No. 17. 1908.

(UNIVERSITY OF LONDON.)

COUNTY COUNCILS OF KENT & SURREY.

THE JOURNAL

OF THE

South-Eastern Agricultural College,

WYE, KENT.

HEADLEY BROTHERS,
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LONDON, AND ASHFORD, KENT.

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EDITORIAL NOTES.

It is satisfactory to record another successful year of the work of the College when this success is measured by the external as well as by the internal activities of the various departments. The College has now however reached its limit of numbers as far as the existing laboratories and lecture rooms can accommodate students, and the number of students for the year under review, 120, marks this limit. The statistics as to the numbers of students since the establishment of the College are as follows—the years marked with an asterisk being those in which enlargements of the College have been made.

1895 (2 terms)	21	1901-2	53
1895-6	33	1902-3	60
1896-7	37	1903-4	74
1897-8	35	1904-5	89
1898-9	47	1905-6	100
1899-1900	51	*1906-7	114
*1900-1901	50	1907-8	120

The consultative work of the College has also considerably increased, and it so appears to retain the confidence of the agricultural and horticultural community of the neighbouring counties.

The Departmental Committee on Agricultural Education and Research having completed the taking of evidence, the report has been issued. The process has been a lengthy one, and it is to be hoped that the definite recommendations will be acted upon, and that an effort will be made to take away from our Government the reproach of being the least alive of any, of at least the continental nations, in fostering agricultural scientific investigation.

There have been a number of changes in the personnel of the Staff, the most important being in the case of Dr. Russell, who has transferred his energy and originality in investigation work to Rothamsted. In the case of research workers, the changes which must necessarily occur on the College staff may be of serious effect as regards the work they are engaged upon, as it may mean not only a break of continuity, but perhaps a transference of activity to some other problem more suited to the new conditions. In the case of Dr. Russell, this is happily not the case, and the investigation work commenced at Wye will be continued and completed at Rothamsted, but the College will always regret the loss to them of a brilliant colleague of such a generous, loyal nature, and endowed with such sound judgment.

Dr. Russell is succeeded by Dr. Goodwin, B.Sc. (Manchester) Ph.D. Göttingen, 1851 Exhibitioner, Queen's College, Galway, who has had much experience in teaching and research work at home and abroad.

Mr. F. Jenkins, B.A. (Cantab.), has been appointed as assistant lecturer and demonstrator on Chemistry and Physics, whilst Dr. Darbishire undertakes the duties of analyst.

Mr. K. J. J. Mackenzie, after being attached to the College as student and teaching member of the staff for some nine years, has been appointed Lecturer in Agriculture at Cambridge, and Mr. B. N. Wale, B.Sc. (Lond.), Silver Medallist, R.A.S.E. F.H.A.S., Agric. Diploma Cambridge Univ., succeeds as Head of the Agricultural Department. Mr. R. N. Dowling, (Dip. S.E.A.C.), P.A.S.I., N.D.A., and Mr. J. Mackintosh, N.D.A., N.D.D., have been appointed assistant lecturers in the Agricultural Department, which has been reorganised and extended.

Mr. C. B. Saunders (Dip. S.E.A.C.), B.Sc. (Lond.), who was in charge of the special Biological and Geological teaching for the London University examinations, has been appointed Lecturer in those subjects at the Holmes Chapel Agricultural College. He is succeeded temporarily by Mr. J. Dunlop, B.Sc. (Glasgow), N.D.A., N.D.D.

Mr. J. C. Brown, P.A.S.I., has been appointed Lecturer in Surveying, and Vice-Principal of the Harper Adams Agricultural College, and he is succeeded by Mr. A. H. J. Haines, whose work will be taken by Mr. A. F. Hood-Daniel.

Miss Price, who for six years successfully presided over the housekeeping department, resigned on account of her marriage. She is succeeded by Miss Harte.

Mr. C. T. Gimingham, A.I.C., takes charge of the Bacteriological and Soil Investigation Departments, which is temporarily housed in Church Gates, where a small laboratory has been instituted.

The College exhibited in three stands at the Lincoln Show 1907, of the R.A.S.E., and a silver medal was awarded in the competitive class to the exhibit of Insects Injurious to Forest Trees, which was collected and set up by Mr. Theobald.

Considerable alterations have been made in the kitchen and domestic departments, whereby greater efficiency and comfort has been secured. The entrance to the sports field has also been enlarged, and a small plantation of conifers established near the entrance, the appearance being thereby greatly improved, and access by wheeled vehicles rendered safer. The cricket pitch has been levelled and relaid, and the thanks of the College are given to those who so generously subscribed to the cost of the work, which amounted to over £80, that no part of the expense fell on the Union Club.

The College is taking its part in equipping with men the Territorial Forces ; a troop of the East Kent Imperial Yeomanry has been formed of the students, an account of which will be found under College News (which is now to be issued as a separate publication during the autumn term) there are also members of other county yeomanry, volunteer and volunteer artillery regiments amongst the College students.

During the year conferences of Fruit-growers, Hop-growers, Potato-growers, and Dairy Farmers have been held at the College. Reports of these proceedings will be found in the pages of the *Journal.* Such conferences do much good, as they bring the workers at the College and their work into more intimate contact and criticism than would the mere dissemination of printed reports and leaflets, and whilst the College work is of a mainly scientific nature, the commercial side is kept well in view, so that to the man who has to win a living from the industry of cultivation, there is much of practical utility to be gained from the papers and from the views of those taking part in the discussions.

The inaugural address of the 1907-8 session was given by the Principal on October 7th, 1907, in which he dealt with the various ways in which students can prepare themselves for their future life work, by means of the College courses, and special emphasis was laid on the point, that the manner in which the courses were taken was of even greater importance than the subjects. There is no room for the "slacker" in the business of farming or in the College, and students were urged to cultivate qualities of keenness, observation and habits of individual work outside the lectures and classes—qualities which, it must regretfully be admitted, are not always engendered in the products of our public school system. The openings in after life for the student who has attended the College were enumerated, and it is most satisfactory to report that, of the number of students who went through the Diploma courses and gained a reputation for honest hard work, all have succeeded in after life.

The number of visitors and of official parties who have, through the year, been to inspect the College and its working, shows a considerable increase, and from the New World as from the Continent and from Scotland and Ireland we have had the pleasure of entertaining representatives.

REPORT

ON THE

FARM AND GARDENS.

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FARM REPORT.

The year June 1907—June 1908 on the whole has been a fairly satisfactory one for the farm, but the absence of sunshine has been against a satisfactory quality in the corn. Wheats gave an average crop, Rivetts proving the most satisfactory commercially, the increased price of 2s. 6d. per quarter in the case of Red Fife being insufficient to produce the same monetary return per acre as from the coarser Rivetts. Barleys were poor quality, the top price, 31s., being made with Goldthorpe. Oats were good, Dalmeny especially proving a good yielder. Roots were good, and proved an adequate supply for our somewhat large head of stock.

Many demonstrations were carried on during the year on points to which students' attention should be directed, but it is not considered necessary to publish the mass of figures in connection with these trials, as at the present time there is such a plethora of reports on "Experiments," many of which are lacking in such essential details as preliminary soil analysis, duplication of plots, etc., that their value cannot be scientific, and must merely be of a local and ephemeral nature.

The crop of best financial return on the farm was potatoes, which yielded a gross return of £37 18s. per acre, or a net return of £21. The season was satisfactory, the market good, and freedom from blight was secured by spraying.

Nine acres of the farm were devoted to potato growing, six acres of Wye Field, and three acres of Field A on Coldharbour.

Digging of the earlies, "Epicure," commenced on July 24th, 1907, the yield being 10½ tons of seed and ware, and 16 cwt. chats per acre; total, 11 tons 6 cwt.

The Sir John Llewellyns were dug after the Epicures, and the returns from one ton of seed planted of these varieties were as follows :—

	Ware.		Seed.		Chats.	Total.	
	Tons	cwts.	Tons	cwts.	Cwts.	Tons	cwts.
Llewellyns	9	13	1	10	10	11	13
Dug Aug. 2nd to 12th.							
Epicures	10	0	2	10	10	13	0
Dug July 24th to Aug. 2nd.							

On September 6th, Factors were dug—one-half of the area devoted to this variety being planted with sprouted sets (which had been boxed since January 7th, and stored in the room by the hop-oast), the other half being planted with unsprouted sets.

The yields were as follows per acre :—

	Ware.		Seed and Chats.	Total.	
	Tons	cwts.	Cwts.	Tons.	cwts.
Sprouted	13	10	10	14	0
Unsprouted	12	2	10	12	12

The total *ware* sold off Wye field was 54 tons 10 cwt.

The prices realised were from 100s. to 65s. per ton.

The system of cultivation is as follows :—

Autumn.—Dung carted on, turned in with shallow furrow. *Winter.*—Ploughed. *April.*—Cultivated, twice harrowed and rolled, ridged, artificial manure distributed, planted, ridges split. *May.*—Twice harrowed, twice scarified, handhoed. *June.*—Earthed up.

In A fields several trials were instituted.

1.—English, Scotch, Irish seed. Up-to-date variety.

Yields per acre, sets 12 in. to 14 in. apart ; rows 27 in. apart.

	Ware.				Seed.				Chats.			Diseased	Total.			
	tons.	cwts.	q.	lbs.	tons	cwts.	q.	lbs.	cwts.	q.	lbs.	lbs.	tons	cwts.	q.	lbs.
English	7	16	3	0	1	2	3	12	17	0	16	5	9	16	3	5
Irish	9	8	3	1		19	1	7	14	1	24	0	11	2	2	4
Scotch	10	11	1	25	1	0	2	0	15	1	0	8	12	7	1	5

The Irish seed was large, 1 ton being required to plant an acre.

The English seed was medium to small, 15¼ cwt. being required to plant an acre.

The Scotch seed was small, 14½ cwt being required to plant an acre.

A trial of fish guano as a dung substitute was made on two quarter-acre plots, 4 cwt. of the " guano " being substituted for 16 tons of yard manure. The difference in yield of *saleable ware* of dunged plot over " guano " plot was 1 ton 14 cwt. (Scotch seed).

The costs of the manure, excluding cost of handling, were

	£	s.	d.
Sixteen tons dung at 5s.	4	0	0
Four hundred-weight " guano " at 7s. 6d.	1	10	0
Difference in favour of " guano "	2	10	0
Value of increased dung-crop at 65s.	5	10	0
Net difference in favour of dung per acre	3	0	0

Live stock had a fairly good year. Beef was rather slow in sale, but at the end of the season some fifteen to sixteen months blue-grey steers of our own breeding and feeding realised excellent prices. A reference to these will be found in Mr. Wale's reports.

Southdown sheep have done better than Kents, as a severe outbreak of tapeworm occasioned many losses amongst the Kent lambs. Lincolns, Oxfords and Suffolks continue to afford an excellent " object lesson " in comparison with the sheep of the district. The lambing records show 262 ewes put to ram, 24 barrens (a high percentage) and 277 lambs.

The wool was sold as in former years, by auction at Guildford, and for the first time our example was followed by other sheep-breeders in the county, who realised higher prices than those locally offered, which were: 6½d. Teg; 4½d. Lamb wool (Kent).

Our wool realised :—

10½d.	for	Southdown Ewe.
11¼d.	,,	Southdown Teg.
7d.	,,	Kent Ewe.
7¾d.	,,	Kent Teg.
7½d.	,,	Crossbreds.
6½d.	,,	Lambs.
5¾d.–6¾d.	,,	Unwashed Wool.

The average weights of fleeces were as follows :—

Average of	Kent tegs washed	6 lbs. 8 ozs.
	Kent ewes	6 lbs.
	Southdown tegs	5 lbs.
	Southdown ewes	4 lbs. 3 ozs.
	Lincoln ewes	7 lbs. 2 oz.
	Oxford ,,	4 lbs. 9 oz.
	Suffolk ,,	4 lbs. 7 oz.
	Southdown X Kent	4 lbs. 3 oz.

The milk yields of the cows are as follows ; no account is taken of the milk consumed by the calf, which in most cases was left on the cow for three days.

No.				Weeks in milk.		lbs. of milk.
1*	Lincoln	Red	6th calf	37		8,666
5	,,	,,		51	(sold fat)	5,809
7*	,,	,,	6th calf	52		5,899
11	,,	,,	3rd calf	43		6,784
13	,,	,,	3rd calf	47		7,784
14	,,	,,	3rd calf	39		7,463
15	,,	,,	3rd calf	42	(sold fat)	7,554
17*	,,	,,	3rd calf	41		5,368
18	,,	,,	3rd calf	39		6,155
19	,,	,,	2nd calf	32	(sold)	4,198
20	,,	,,	2nd calf	45	(sold)	6,085

* To be drafted out.

The young stock, all by Wye College Rufus out of the best milkers, promises exceedingly well.

No.		Weeks in milk.	lbs. of milk.
1	Shorthorn	43	7,656
2	,,	35	4,782
3	,,	48	9,955
4	,,	44	6,535
5	,,	39	6,666
7	,,	55	7,402

The milk yields are perhaps lower than they would be if some of the cows were not used for the purposes of the instruction of students in milking.

REPORT ON BULLOCK FEEDING EXPERIMENTS.

By W. R. Tucker and B. N. Wale, B.Sc. (Lond.).

Objects of the Experiments.

(1) To investigate the possibility of replacing roots in a fattening ration by one of the treacle foods,—in this case, Molascuit.

(This question might arise after a bad root season, or where grass land farmers have to purchase roots for fattening cattle.)

The treacle foods consist of molasses or treacle mixed with and absorbed by fibrous materials which may or may not have any feeding value. The chief materials used are peat moss—the mégasse or residue of the sugar cane after extraction of the sugar—rice husks, dried lucerne or sainfoin. The relative values of these foods have not yet been ascertained, but they would be sufficiently accurately estimated in the sugar content and price basis. In these trials Molascuit was used—this contains 45 per cent. of sugar, and the absorbent material is the sugar cane residue.

(2) To give a practical demonstration to the students on the beef-producing capacity of several breeds of cattle.

In all, ten animals, ranging from eighteen to thirty months old, were included in the experiment. Of these, eight were purchased in pairs at different markets, and consisted of :—

Two Hereford bullocks purchased at Shrewsbury.
Two Crossbred Scotch Polled bullocks at Shrewsbury.
Two Sussex bullocks at Robertsbridge, Sussex.
Two Devon bullocks at Guildford.
Two Shorthorn heifers bred on the College Farm.

The cattle were all tied up, in pairs of each breed, in the fattening sheds, and had similar food for a week or two after they were purchased, and before the experiment proper commenced.

The animals were numbered from one to ten, and divided into two lots, consisting of the following :—

LOT 1.	LOT 2.
No. 1 Shorthorn.	No. 2 Shorthorn.
,, 3 Hereford.	,, 4 Hereford.
,, 5 Scotch Polled.	,, 6 Scotch Polled.
,, 7 Sussex.	,, 8 Sussex.
,, 9 Devon.	,, 10 Devon.

Foods Given.

The cattle in Lot 1 besides cake, meals and chaff, were fed as many sliced roots—at first swedes and later mangolds—as they would eat, these, like all the other foods, being weighed out each day.

The cattle of Lot 2 received similar food to those of Lot 1, except that they were fed Molascuit instead of roots.

The Molascuit cost £5 5s. per ton, and the value put upon the roots (swedes and mangolds) was 7s. 6d. per ton ; hence 1 lb. of Molascuit was considered equal to 14 lbs. of roots in money value.

The quantity of food given to each pair of animals varied according to their age, but the quantity of foods fed to each animal was weighed out and recorded, so that the total quantity of each food received by any animal was known. The average daily ration fed to each animal at the beginning of the experiment was :—

	Lot 1.	Lot 2.
Foods.	lbs.	lbs.
Linseed Cake	2	2
Bombay Cotton Cake	2	2
Rice Meal	2	2
Chaffed Straw	5	5
Hay	6	6
Roots	35	—
Molascuit	—	2½

The cakes were increased gradually from 2 lbs. to 2½ and to 3 lbs. for each animal by the end of the feeding period.

The rice meal was raised to 3 lbs. during the first month of feeding.

The chaff, which consisted first of barley awns, and later of wheat chaff, was raised in the case of the larger animals to 8 lbs. each, and as Lot 2 (Molascuit) received less bulk of food, *i.e.*, 2½ lbs. Molascuit instead of 35 lbs. roots, they appeared somewhat empty, so that 3 lbs. more chaff was fed to each animal in Lot 2 than was fed to each animal of Lot 1. This change was made at the end of the first month.

The hay was reduced all round to 5 lbs. per head during the second week of the experiment, as 6 lbs. was found to be more than the animals would eat.

The roots were raised from 35 to 42, 49 and 56 lbs. each in the case of the larger animals. The smaller beast could not be induced to take more than 49 lbs. roots daily.

The molascuit was increased in proportion, as the roots were increased, from 2½ lbs. to 3 lbs., 3½ lbs. and 4 lbs. each daily.

The chaff, meals, and roots, in Lot 1 and the chaff, meals, and molascuit in Lot 2 were fed mixed together after having been moistened with water.

Water was given *ad libitum*, and it was found that the animals receiving no roots, Lot 2, drank about four times the amount of water as was drunk by Lot 1.

Live Weights.

The live weights of the cattle at the beginning of the experiment, December 7th, 1907, were as follows :—

	Lot 1 (roots).			Lot 2 (molascuit).		
	cwt.	qrs.	lbs.	cwt.	qrs.	lbs.
Shorthorns	11	0	26	10	3	0
Herefords	9	2	10	9	3	14
Scotch Polled	9	0	24	9	0	6
Sussex	7	2	20	7	2	26
Devons	9	0	24	9	2	14
Total	46	3	20	47	0	4
Average	9	1	15	9	1	17

It will be seen from the above weights that although the bullocks of different breeds varied considerably, those of the same breed showed only slight differences.

Periodical Weighings.

During the experiment, the cattle were weighed regularly once every week at 11 a.m. on Saturday mornings; but as the introduction of the figures of the weekly weighings into this report would make it very cumbersome without adding to its value, the monthly weighings only are given below :—

LOT 1. (ROOTS).

	Shorthorn.			Hereford.			Scotch Polled.			Sussex.			Devon.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
Dec. 7th	11	0	26	9	2	10	9	0	24	7	2	20	9	0	24
Jan. 4th	12	1	6	10	1	22	9	2	11	8	3	1	9	3	8
Feb. 1st	12	3	17	10	3	20	10	1	15	9	2	0	10	2	0
Feb. 29th				11	1	21	10	2	17	9	3	20	10	2	26
Mar. 28th				12	0	2	11	0	20	10	0	14			
May 12th										10	2	9			

LOT 2. (MOLASCUIT).

	Shorthorn.			Hereford.			Scotch Polled.			Sussex.			Devon.		
	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.	Cwt.	qrs.	lbs.
Dec. 7th	10	3	0	9	3	14	9	0	6	7	2	26	9	2	14
Jan. 4th	11	0	6	10	1	15	9	3	22	8	1	26	9	3	21
Feb. 1st	11	3	22	10	2	13	10	2	26	9	0	21	10	3	15
Feb. 29th				11	0	12	10	2	15	9	3	2	10	3	25
Mar. 28th				11	2	3	11	0	14	9	3	1			
May 12th										10	0	14			

In the following table, the actual average daily increase in live weight for each month's feeding is given :—

Lot 1 (Roots).

Breed.	No. of weeks fattening.	Average daily increase in lbs. live weight.				Average daily increase for whole period
		1st Month.	2nd Month.	3rd Month.	4th Month.	lbs.
Shorthorns -	11	4.44	2.39	1.23	Sold	2.71
Hereford -	17	3.55	1.26	1.96	2.32	2.32
Scotch Polled	18	1.59	3.14	1.03	2.10	1.42
Sussex -	22½	5.22	2.96	1.65	.78	2.19
Devon- -	13½	2.51	2.71	.89	Sold	2.02
Average of the five beast	16	3.46	2.49	1.34	1.73	2.13

Lot 2 (Molascuit).

Breed.	No. of weeks fattening.	Average daily increase in lbs. live weight.				Average daily increase for whole period
		1st Month.	2nd Month.	3rd Month.	4th Month.	lbs.
Shorthorns -	10½	1.25	3.57	—.11	Sold	1.82
Hereford -	18½	2.11	.92	1.89	1.67	1.16
Scotch Polled	18	3.70	3.14	—.37	1.96	1.00
Sussex -	22½	3.11	2.82	2.24	0	1.70
Devon -	13½	1.29	3.78	.34	Sold	1.80
Average of the five beast	16½	2.29	2.84	.79	.72	1.49

It will be seen from the above table that the figures in the column "Average daily increase for whole period" do not form the average of the three or four monthly daily increases. This is because parts of a month in addition to the full month had to be taken into account in forming the last column.

The table shows, however, that the average daily increase per head over the whole period was :—

2.13 lbs. live weight in Lot 1 (Roots), and
1.49 lbs. live weight in Lot 2 (Molascuit).

Disposal of the Fat Cattle.

The cattle were sold by weight to Mr. Maxted, of Wye, who very kindly offered every facility for weighing and examining the carcases.

The prices obtained were :—

11s. 3d. per score for the Sussex and Devons, and 11s. per score for the remainder.

As the cattle were of different degrees of fatness when the experiment started, they were killed as they became ready, but each pair of the same breed were slaughtered the same week, so that a fair comparison could be made.

The Scotch Polled beast were bad doers, and after being tied up for eighteen weeks they were turned into a yard with shed at one end and fed with roots and molascuit in addition to meals and cakes, etc. Hence, as far as this experiment is concerned, they will not be further considered.

Carcase Weights.

The carcase weights of the remainder were as follows :—

	Lot 1 (roots).		Lot 2 (molascuit).	
	scores	lbs.	scores	lbs.
Shorthorns	39	7	32	8
Hereford	37	5	33	9
Sussex	31	6	27	7
Devon	32	4	32	13
Total	140	2	125	17
Average	35	0	31	9

It will be seen on reference to the above figures that Lot 1 (roots) gave a much better result than Lot 2 (molascuit).

At the same time it is only fair to say that two of the bullocks in Lot 2 (molascuit) did very badly. (This, perhaps, is not so apparent from the figures showing the live weight gains, but is more patent when reference is made to the percentage of carcase to live wight given below.)

The Shorthorn heifer in Lot 2 did not eat well or do well during the later stages, and on slaughtering this animal, a large tumour was found on the liver, which was responsible for a poor development of internal fat over the kidneys.

Also the Sussex bullock in Lot 2 scoured at times, and fell off during the last month of feeding. This bullock was probably exceptional in this respect, as scouring did not occur with the other molascuit-fed beast; in fact, as far as consistency of the dung was concerned, molascuit proved a very suitable food.

Percentage of Carcase to Live Weight.

The live weights were taken as usual about 11 a.m., and 7 per cent. was deducted from these weights to allow for shrinkage that would probably take place in fasting and marketing, if the beast had been driven to market.

Fasted live weights, dead weights, and percentage of carcase to live weights :—

	Lot 1 (Roots).					Lot 2 (Molascuit).				
	Fasted live weight.			Dead weight.	Per cent. carcase to live weight	Fasted live weight.			Dead weight.	Per cent carcase to live wght.
	Cwt.	qrs.	lbs.	sc. lbs.		Cwt.	qrs.	lbs.	sc. lbs.	
Shorthorn	12	0	21	39·7	57·65	11	0	11	32.8	52.13
Hereford -	11	0	14	37·5	59·74	10	1	18	33·9	57·37
Sussex -	9	3	10	31·6	56.80	9	1	19	27·7	51.84
Devon -	10	0	17	32.4	56.64	10	1	11	32.13	56.34
Average					7·70					54·42

The results above tabulated show that the percentage of carcase was 3.25 per cent. higher in the case of the root lot than in the case of the molascuit lot.

The Molascuit beast did not handle so well as the Roots beast, their flesh appeared softer to the touch, though their appearance was not much inferior to the root lot.

Monetary Results.

This experiment from its very nature could not be expected to turn out profitably, chiefly because one of the main objects was to familiarise the students with the different breeds. These animals had to be purchased on commission at distant markets, and this, coupled with the railway expenses incurred in getting the animals to Wye, made the price per head and per cwt. live weight higher than a practical agriculturist would be warranted in giving.

Value of the animals at the commencement of the experiment.

	Price per head £	s.	d.	Price per cwt. live weight.
Shorthorns	15	15	0	30s.
Herefords	15	10	0	33s. 7d.
Scotch Polled	14	15	0	33s. 9d.
Sussex	12	10	0	31s. 9d.
Devons	16	5	0	35s. 1d.

Cost per ton of Foods fed.

	£	s.	d.
Linseed Cake	8	5	0
Cotton Cake	4	15	0
Rice Meal	5	15	0
Chaffed Straw	1	10	0
Hay	3	10	0
Roots		7	6
Molascuit	5	5	0

Profit and Loss.

Below is given the cost of the food consumed by each animal; attendance is charged at 6d. per week, and the manurial values are based on Hall & Voelckers' recent estimates (Royal Agricultural Society's Journal, 1902).

LOT 1 (ROOTS).

	Shorthorns.			Hereford.			Sussex.			Devon.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Cost of food - -	3	12	4	5	5	5	7	4	4	4	3	9
Attendance - -		5	6		8	6		11	3		6	9
First cost of animal -	15	15	0	15	10	0	12	10	0	16	5	0
Total - - -	19	12	10	21	3	11	20	5	7	20	15	6
Manurial Value - -		18	6	1	6	4	1	17	2	1	4	5
Balance - - -	18	14	4	19	17	7	18	8	5	19	11	1
Price of fat animal -	21	12	10	20	9	2	17	12	0	18	2	3
Profit + Loss — - -	+3	8	6		+11	7		—16	5		—18	10

Average profit per head - 11s. 2½d.

LOT 2 (MOLASCUIT).

	Shorthorns.			Hereford.			Sussex.			Devon.		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
Cost of food - -	3	11	2	5	9	0	7	9	5	4	6	4
Attendance - -		5	3		8	6		11	3		6	9
First cost of animal -	15	15	0	15	10	0	12	10	0	16	5	0
Total - - -	19	11	5	21	7	6	20	10	8	20	18	1
Manurial Value - -		17	2	1	6	8	1	14	8	1	0	8
Balance - - -	18	14	3	20	0	10	18	16	0	19	17	5
Price of fat animal -	17	16	5	18	12	10	15	7	8	18	17	1
Profit + Loss — -		—17	10	—1	8	0	—3	8	4	—1	0	4

Average Loss per head - £1 13s. 7½d.

The figures show an average profit per head of 11s. 2½d. in Lot 1, and an average loss per head of £1 13s. 7½d. in Lot 2.

Summary.

In the first place an experiment like the above requires at least another test of a similar nature giving corroborative results before we can definitely say the advantage of roots over molascuit for fattening purposes is so pronounced.

It is necessary in summarising the results to bear in mind that two beast of Lot 2 (molascuit) were bad doers,—the Shorthorn being unsound and the Sussex frequently upset by scouring.

It cannot be claimed that the nature of the food was responsible for this ; because the dung from the other beasts of Lot 2 was quite normal, and showed no indication of laxity. The experiment would indicate that roots cannot economically be displaced by molascuit, at any rate during the whole feeding period. It would appear, however, that molascuit gave very good results during the first two months of the feeding period, but for "finishing off," the cattle, roots produce a firmer and less watery beef.

Again it is necessary to bear in mind the figures put upon the home-grown produce.

Is 7s. 6d. per ton a fair value to put upon roots grown on the farm ? Where the produce per acre does not exceed twenty-five tons, probably this does not cover the cost of raising the crop, and is therefore too low.

The same may be said for hay and straw.

For a profit to have been realised in the case of the Lot 1 (roots), at least 2s. per cwt. less should have been paid when the cattle were purchased. With the present prices of foodstuffs it would seem impossible to make a profit on fattening cattle if more than 31s. or 32s. per cwt be paid for them at the time they are put up to fatten.

It will be seen on reference to the live weight gains that the cattle in Lot 1 (roots) made very fair daily increase, and in general practice this would probably not be exceeded. Hence the quantity and quality of the food given would appear to be very suitable for beef production.

In conclusion, our thanks are due to Mr. Wellington, who rendered valuable assistance by undertaking the feeding of the bullocks during the Christmas vacation.

REPORT ON PIG FEEDING EXPERIMENTS..

By F. Blagrove and B. N. Wale, B.Sc. (Lond.)

Experiment I.

Object of the Experiment.

The object of the experiment was to compare Rice meal with Barley meal for pig-fattening purposes.

Rice meal was especially selected on account of its relative cheapness as compared with other pig fattening foods. It was purchased at £5 15s. per ton, while Barley Meal and Middlings were quoted at £6 5s. to £6 10s. per ton at the same time.

Age and Live Weight of Pigs.

The pigs were of the Large Black (Kent) breed, and were selected from two litters ; at the time the experiment commenced they were twelve weeks old.

Five pigs were selected for each lot, three from one litter and two from the other.

The live weights at the beginning of the experiment were :—

No of Pig.	Lot 1 (Rice Meal).	Lot 2 (Barley Meal).
1.	50	53½
2.	48	50¼
3.	45	46¾
4.	43¾	40½
5.	40¾	36¼
Total 5.	227½	227¼
Average weight per pig	45½	45½ nearly.

It will be seen that the average live weight per pig was as near as it was possible to obtain.

Preparation of the Food.

As the pigs had previously been fed on barley meal, only one-third of this was replaced at first by rice meal in Lot 1. The meals were carefully weighed out and then placed in water to soak for twelve hours before feeding. The ration consisted of meal and water only.

Quantity of Food given.

At the commencement each pig received 2 lbs. of meal per head daily. For Lot 1 this was gradually increased as the pigs would take it, to 3 lbs. by the eighth week, and by that time the proportion of rice meal had been increased from a quarter to three-quarters of the total meal fed.

The reason that rice meal did not entirely replace barley meal was that the pigs could not be induced to take it. After six weeks feeding 1 lb. of a treacle food was added to the diet of Lot 1 with the aim of increasing its palatability, but without success. The pigs never eagerly took the rice meal during the whole feeding period.

In Lot 2 (barley meal) the pigs ate up their food with much greater relish, and as the following figures show, made much better growth, so that they were able to take a greater weight of food each day; thus while starting on 2 lbs. meal per head per day, they were taking 3½ lbs. by the eighth week.

Periodical Weighings.

The pigs were weighed separately once a fortnight; the weights of the five pigs in each lot are given below:—

LOT 1.

Food.	Nov. 25	Dec. 9.	Dec. 23.	Jan. 6.	Jan. 20.	Feb. 3.	Feb. 17.	Gain for 12 weeks.	Average gain of 5 pigs per week in lbs.
Rice Meal and Barley Meal	lbs. 227⅛	lbs. 245¼	lbs. 268¼	lbs. 284¼	lbs. 316½	lbs. 332¼	lbs. 352¼	lbs. 124¾	10½

LOT 2.

Barley Meal only -	lbs. 227¼	lbs. 261	lbs. 294¾	lbs. 333½	lbs. 381½	lbs. 406¼	lbs. 440¾	lbs. 213½	18

From these figures it is seen that the gain for the twelve weeks was—

Five pigs in Lot 1	124¾ lbs. or 25 lbs. (nearly) per pig.
Five pigs in Lot 2.	213½ lbs. or 48½ lbs. per pig.

Summary.

The pigs of Lot 2 (barley meal) gained nearly twice as much as those in Lot 1 (rice meal). At the same time Lot 1 appeared very unthrifty, were dry and scaly on the skin, and never eagerly ate their food.

For these reasons it was not thought desirable to continue the experiment further on the same lines. Judging from the results obtained, rice meal for pigs as young as those experimented upon (twelve weeks) is not a suitable food, even when it forms only a portion of the total meal fed, especially when the liquid portion consists of water only.

There is no doubt that rice meal is not sufficiently rich in nitrogenous matter, *i.e.*, its albuminoid ratio is too low for growing pigs.

Taking the digestible matter only into account, the albuminoid ratios of the two meals are :—

Rice meal	1 : 11
Barley meal ..	1 : 9

Rice meal fed with a highly nitrogenous food like separated milk (which possesses an albuminoid ratio of 1 : 1½) has been shown to be a very suitable food for young pigs. (See Massachusetts Station Report, 1897).

EXPERIMENT 2.

Object of the Experiment.

To see the effect of reversing the diets for the pigs in the above experiment.

The same pigs were used as in last experiment ; Lot 1 (rice meal) now received barley meal only, while Lot 2 (barley meal) now received a mixture of rice and barley meals. The experiment lasted eight weeks.

The weights at the beginning of the experiment and the periodical weights thereafter for the five pigs in each lot are given below.

LOT 1.

Food.	Feb. 17.	Mar. 7.	Mar. 28.	Apr. 11.	Gain for 8 weeks.	Average gain per week.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Barley Meal only - -	352¼	380¼	428¾	457¾	105½	15½

LOT 2.

Food.	Feb. 17.	Mar. 7.	Mar. 28.	Apr. 11.	Gain for 8 weeks.	Average gain per week.
	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
Rice Meal and Barley Meal	440¾	504¾	540½	570¼	129½	16¼

It will be seen that the change of diet acted beneficially when barley meal was substituted for rice meal in Lot 1, the average gain per week now being 15½ lbs. as against 10½ lbs. when rice meal had previously been fed.

But in Lot 2 where rice meal was substituted for barley meal, the gains fell off from 18 lbs. per week to 16¼ lbs. per week.

Bearing in mind that the pigs of Lot 2 were almost 25 per cent. heavier to start with, the gains shown under rice meal feeding are larger than would have been the case had Lot 2 pigs been no heavier than Lot 1.

Lot 2 (rice meal) pigs at first, owing to their greater size, ate more meal than Lot 1, but not liking the rice meal, they consumed less towards the end of the experiment than Lot 1.

Summary.

The result of this experiment corroborates that of the previous one, again showing that rice meal cannot form a large proportion of the total meals fed to pigs unless it is associated with some other meal possessing a richer albuminoid ratio, or some highly nitrogenous liquid food, like separated milk, whey, or good wash instead of water.

Further, the same holds good whether the pigs be three or five months old.

DAILY GAINS IN LIVE WEIGHT OF CATTLE AND SHEEP.

By B. N. Wale, B.Sc. (Lond.).

A number of regular weighings of live stock have taken place since last autumn with the aim of obtaining some data showing what daily gains it is possible for farm animals to make under ordinary conditions.

The stock under investigation consisted of :—

(1) **Cattle.**
  - (*a*) Yearling calves to be run on as stores.
  - (*b*) Ditto for early maturity.
  - (*c*) Fattening cattle.
  - (*d*) Bull in breeding condition, two-and-a-half years old.

(2) **Sheep.**
  - (*a*) Young lambs kept in store condition.
  - (*b*) Tegs fed off at from nine to twelve months old.

Cattle.

Dealing with cattle first, the following were the daily rations during December and January, which will give some idea of the average diet fed.

(*a*) Yearling calves to be run on as stores.

1 lb.	Linseed cake.
2 lbs.	Cotton cake.
25 lbs.	Roots.
	Straw *ad. lib.*

(*b*) Calves to be fattened for baby beef.
2 lbs. Linseed cake.
1 lb. Cotton cake.
1 lb. Molascuit.
6 lbs. Hay.
18 lbs. Roots.

(*c*) Fattening cattle 19 to 22 months old.
5 lbs. Linseed cake.
3 lbs. Cotton cake.
1 lb. Molascuit.
9 lbs. Hay.
50 lbs. Roots.
Straw *ad. lib.*

(*d*) Two-and-a-half year old bull in breeding condition, improving for sale.
2 lbs. Linseed cake.
2 lbs. Cotton cake.
1 lb. Molascuit.
30 lbs. Roots.
Hay *ad. lib.*

Sheep.

(*a*) Lambs about 2½ months old, still with their dams.
Grass *ad. lib.*
Mangolds ,,
Hay ,,
Cake ,,

(*b*) Fattening tegs 9 to 12 months old.
Roots *ad. lib.*
¾ lb. Hay chaff.
¾ lb. Cake and grain.

Periodical Weighings.

In the following table the periodical weighings are omitted for the sake of simplicity, the dates during which the weights were recorded, being given instead. The figures indicate the average daily live weight gains for each animal during the period under observation, and also the average live weight gain where the observations include a number of animals of similar age and dieting.

CATTLE.

	Period under observation.	Total gain in lbs. live weight.	Gain per head per day in lbs.	Average daily gain per head.
(*a*) *Yearling Calves.*				
No. 1	May 7th to May 16th	14	.20	.81
2	ditto	8	.11	
3	ditto	2	.02	
4	ditto	130	1.85	
5	ditto	88	1.25	
6	April 4th to May 16th	61	1.45	
(*b*) *Calves for early maturity.*				
No. 1	Oct. 24th to May 16th	347	1.69	1.84
2	ditto	390	1.90	
3	Nov. 30th to May 16th	378	2.25	
4	ditto	264	1.50	
5	ditto	281	1.67	
6	ditto	359	2.13	
7	ditto	278	1.76	
(*c*) *Fattening Cattle.*				
No. 1	Oct. 24th to Feb. 22nd	221	1.82	1.88
2	ditto	229	1.89	
3	Oct 24th to May 16th	263	1.75	
4	ditto	368	2.35	
5	Oct. 24th to Dec. 14th	82	1.60	
(*d*) *Bull*	Nov. 1st to Mar 7th	168	1.40	1.40

SHEEP.

(*a*) Lambs 2½ months.	Wgt. at birth lbs.	Period under observation.	Total gain in lbs. live weight.	Gain per head per day lbs.	Average daily gain per head.
Hampshire × Kent -	13	Mar. 6th to May 21st	38½	.87	.82
Kent × Suffolk -	13	Mar. 7th to May 21st	42	.93	
Hampshire × Lincoln	9½	Mar. 9th to May 21st	45	1.04	
Kent - - -	12½	ditto	34	.79	
Southdown - -	7½	ditto	21½	.50	
Southdown × Oxford	13	Mar. 19th to May 21st	31½	.95	
Southown × Kent -	9½	Mar. 9th to May 21st	30	.69	

(*b*) Fattening Tegs. 9–11 months old.	Live weight when sold.	Period under observation.	Total gain in lbs. live weight.	Gain per head per day lbs.	Average daily gain per head.
No. 1	130	Mar. 15th to Dec. 10th	119	.43	.36
2	117	ditto	106	.39	
3	116	Mar. 15th to Jan. 20th	105	.33	
4	138	ditto	127	.40	
5	126	ditto	115	.37	
6	115	Mar. 15th to Feb. 11th	104	.31	
7	122	ditto	111	.33	

Those observations extended over a considerable period will naturally be of most value. Hence those recorded for the first lot of animals, viz., yearling calves to be run on as stores, will be of least importance in this respect, though even in these, good averages are obtained.

Those animals destined for early maturity and the fat animals naturally show the best gains; while store animals and those having reached the adult condition show less daily gain.

In considering the figures dealing with sheep, the most noticeable feature is the high rate of daily gain in the case of the very young animal, viz., up to two-and-a-half months of age.

Where the age approaches a year, the average daily gain is reduced to less than half that made by the younger animals.

CROSS-BRED TEGS.

By B. N. Wale, B.Sc.

The following cross-bred tegs have been raised on the farm, their ages were approximately the same, viz. :—just over one year.

The following figures give an indication of the live weights according to the crosses made. The tegs were in store condition and were sold at Ashford Market on April 3rd of this year.

Lots.	No. of Tegs.	Description.	Total live weight, lbs.	Average live weight per head in lbs.
1	1	Kent × Oxford - - -	101	101
2	1	Suffolk × Lincoln - - -	95	95
3	7	Hampshire × Kents - - -	648	92½
4	1	Kent × Suffolk - - - -	88	88
5	4	Suffolk × Kents - - -	352	88
6	5	Shropshire × Kents - - -	438	87½
7	4	Southdown × Southdown-Suffolks	334	83½
8	3	Southdown × Suffolks - -	250	83
9	4	Southdown × Kents - - -	308	77

In the table the name of the breed of sheep mentioned first refers to the ram, and the following name the ewe. Thus Lot 1 was a lamb produced by a Kent ram on an Oxford ewe. Lot 7 were produced by a Southdown ram on cross-bred ewes, viz. :— Southdown Suffolks.

At the time of sale of the above cross-bred tegs in Ashford there was also sold a number of Kent and Southdown tegs bred on the College Farm.

The weights and prices obtained are given below :—

No. of Tegs.	Description.	Total live weight.			Live weight per head.	Price per head.	Price in pence per lb. live wt.
		Cwts.	qrs.	lbs.	lbs.		
21	Kents - - -	19	1	15	103	43/6	5.06
11	Kent Culls - -	7	0	14	72	34/6	5.07
23	Southdowns -	18	2	15	90	37/6	5.00
15	Crossbreds - -	13	1	1	99	41/6	5.03
15	Ditto smaller -	10	3	14	81	37/-	5.48

The sheep were actually sold at so much per head. The live weights are those recorded at the College Farm where the sheep were weighed the day before the sale.

It will be seen from the above that the prices obtained per head worked out to almost the same price per lb. live weight (with the exception of the small cross-breeds which made nearly ½d. per lb more). This indicates very good judgment on the part of the buyers.

CALF REARING.

A trial was made of a substitute for milk in calf rearing other than those mentioned in the leaflet No. 142 of the Board of Agriculture. A mixture of treacle and malt culms of the same nutritive value as milk was used, this mixture being gradually substituted for new milk in the feeding of the calves, but the effect on the animals was to cause scouring and consequently the trial was discontinued. The amount of fibre in the malt culms was the cause of the scouring, and other foods of an equally nutritious and less fibrous nature will have to be experimented with.

COTTON SEED OIL FOR CALF FEEDING.

Object of the Experiment.

The object of this experiment was to see whether cotton seed oil could be used as a cream substitute, *i.e.*, the oil to be fed with separated milk.

It has been conclusively shown that cod liver oil forms a very economical substitute for cream, when fed with separated milk, but cod liver oil possesses a disagreeable odour which is objectionable where the preparation of the calves' food takes place adjacent to, or actually inside the farmer's kitchen, as well as being liable to adulteration with cheaper and unsatisfactory fish oils. Cotton seed oil is free from all strong odour, and is also cheaper, the price being 2s. 5d. per gallon, against 4s. 6d. to 5s. for cod liver oil.

Age of Calves for Experiment.

There were no calves at the College farm of the right age,—a fortnight old, to experiment upon ; but it was thought that a preliminary test might be made on somewhat older calves, viz., eight weeks.

Up to this time the calves had been receiving new milk only. They were six in number, divided into two lots of three each.

Quantity of Food Given.

The experiment lasted five-and-a-half weeks ; at the beginning, of this period, Lot 1 received eight quarts new milk per head daily for the first week, increased to nine quarts daily during the second week, and then gradually decreased by substituting linseed cake gruel, until the fourth week, when the new milk which had been reduced to four quarts daily remained at that quantity until the end of the experiment.

Lot 2 received half separated milk and half new milk for the first week, viz., four quarts of each daily ; during the second week no new milk was fed, its place being taken by nine quarts separated milk daily, which was increased to ten quarts during the third week, and remained at that quantity for the remainder of the period. The cotton-seed oil was added to the separated milk and thoroughly stirred in. The quantities fed per calf per day were at first one-and-a-half, then two, and finally three table spoonfuls ; the oil being increased along with the separated milk.

Each calf of both lots received a weighed quantity of hay daily which averaged about 1⅓ lbs., and in addition finely ground linseed cake fed in the dry condition, starting with 4 oz. per head daily for the first week and then 6 oz. per head daily for the remaining four-and-a-half weeks.

The liquid food was fed to all the calves at a temperature varying from 90° to 95° F.

Value of the Foods Given.

New milk is reckoned to be worth 7d. per gallon on the farm.

Separated milk is valued at 1d. per gallon.

Linseed cake at £8 10s. per ton, ground.

For purposes of comparison only those foods which differed for the two lots are valued in the table below, the cost of the other foods being the same for the two Lots.

Comparative cost of the two rations :—

Lot 1.				Lot 2.			
Total quantity of food given during the 5½ weeks.	£	s.	d.	Total quantity of food given during the 5½ weeks.	£	s.	d.
56 gals. new milk per calf @ 7d. - -	4	18	0	4½ gals. new milk per calf @ 7d. - -		7	10½
18⅓ lbs. Linseed cake per calf as gruel @ £8 10s. per ton- -		4	2	84¾ gals. separated milk per calf @ 1d. - -	1	1	2¼
				1⅒ qts. Cotton Seed Oil per calf @ 2s. 5d. per gal. - - -		2	0¼
Cost for 3 calves - -	5	2	2		1	11	1¾
Cost per calf - -	1	14	1			10	4½

This shows that the cost of the trial foods of Lot 1 was more than three times greater than that of Lot 2.

The calves of Lot 2 appeared to thrive well, and the cotton seed oil did not in any case produce either scouring or the opposite effect.

Live Weights.

The live weights at the beginning and during the experiment were as follows :—

LOT 1.—NEW MILK AND LINSEED CAKE GRUEL

No. of Calf.	At starting, April 4th.	April 18th.	May 12th.	Increase for whole period.	Increase per head per week.
	lbs.	lbs.	lbs.	lbs.	lbs.
1	163	189	226	63	11.5
2	146	168	193	47	8.5
3	131	147	178	47	8.5
Total - -	440	504	597	157	28.5
Average per head	146	168	199	53	9.6

LOT 2.—SEPARATED MILK AND COTTON SEED OIL.

Separated Milk and Cotton Seed Oil.	At starting, April 4th.	April 18th.	May 12th.	Increase for whole period.	Increase per head per week.
	lbs.	lbs.	lbs.	lbs.	lbs.
1	196	224	252	56	10.25
2	155	182	210	55	10.
3	151	168	196	45	8.25
Total - -	502	574	658	156	28.5
Average per head	167	191	219	52	9.5

The results show that the live weight increase per head per week was approximately the same in the case of the two lots, viz., 9.6 and 9.5 lbs. respectively.

It is only fair to state, however, that two of the calves in Lot 1 (new milk and linseed cake gruel) could not be induced to eat their full daily allowance of dry cake, otherwise the live weight gains in Lot 1 would probably have been slightly better than was actually obtained in the experiment ; still such increased gain would have been obtained at a considerably greater cost as the table containing the cost of foods shows.

Summary.

Such good results with cotton seed oil have been obtained in this preliminary experiment that it would appear this oil may form a useful cream substitute, though it is possible that it may not be suitable for young calves at that age (viz., two to four weeks old), at which a cream substitute should, from the point of economy, begin to form a part of the ration.

It is hoped to carry out a further experiment on the same lines, to test the correctness of the results obtained above.

Very valuable assistance has been rendered by several students who have carried out the actual feeding of the calves, and thus brought the experiment to a successful issue ; thanks are especially due to Messrs. Thornley, Warry and Searle.

QUANTITY OF CONCENTRATED FOOD FED TO FATTENING BULLOCKS.

By B. N. Wale, B.Sc. (Lond.).

On reference to the report on " Bullock Feeding Experiments " page 20, it will be seen that the average daily gain through the whole fattening period of the bullocks in Lot 1 was 2.13 lbs. per head daily. These figures represent quite as much daily gain as can be expected in fattening bullocks, under average conditions.

Again on reference to the report on " Daily Gains in Live Weight," page 31, it is seen that in the case of fattening cattle there given, the average daily gain in live weight was 1.88 lbs. Now the latter cattle were of similar age to the former, hence they may be fairly used for purposes of comparison, but the point to be noticed is that Lot 1 received a cheaper diet than the cattle last referred to, which may be called Lot 2.

Foods received by the Cattle.

The average rations for the two lots of cattle may be thus given :—

Lot 1 (cheap ration).	Lot 2 (dear ration).
3 lbs. Linseed cake.	5 lbs. Linseed cake.
3 lbs. Cotton cake.	3 lbs. Cotton cake.
3 lbs. Rice meal.	1 lb. Molascuit.
5 lbs. Hay.	10 lbs. Hay.
5 lbs. Straw.	50 lbs. Roots.
50 lbs. Roots.	

To bring out the essential difference in the two rations only the quantities of food which varied, are given below.

Lot 1.	Lot 2.
3 lbs. Rice meal.	2 lbs. Linseed cake.
5 lbs. Straw.	1 lb. Molascuit.
	5 lbs. Hay.

Estimating these at the prices per ton already given in the report on "Bullock Feeding Experiments," page 22, the relative cost of the variant foods per head per day is :—

Lot 1.			Lot 2.		
Rice meal	1.83	pence	Linseed cake	1.76	pence
Straw	.80	,,	Molascuit	.56	,,
			Hay	1.85	,,
	2.63	,,		4.17	,,

It is seen from the above therefore that the ration of Lot 2 cost 4.17d.—2.63d.=1.54d. or over 1½d. per head daily more than the ration of Lot 1, and yet gave less live weight increase. It might be urged that such loss is made up for in the manure. The following figures will show whether that is so.

Taking Hall & Voelcker's figures as basis for the value of the manurial residue, the result is :—

Lot 1.			Lot 2.		
Rice meal	.21	pence	Linseed cake	.40	pence
Straw	.16	,,	Molascuit	.17	,,
			Hay	.40	,,
Total manurial value per day	.37	,,		.97	,,

On subtracting these from the values of the food, the following figures are obtained as the actual cost of the foods for beef production.

Lot 1. 2.63d.—.37d.=2.26d.

Lot 2. 4.17d.—.97d.=3.20d.

Hence when the value of the manurial residue is allowed for the cost of the ration for Lot 2 is still about 1d. per head per day dearer than in Lot 1.

Farmyard manure, as is well known, not only benefits the land from the fertilising ingredients that it contains, but also improves the texture of the soil, sets free other plant food in the soil, and keeps the land moist in dry weather. Yet a manure containing less fertilising matter, like that produced by Lot 1, would serve all these purposes equally well. Therefore it must be concluded that in the above case, the richer feeding has been less profitable than that obtained from the poorer diet.

Summary.

When the price of feeding stuffs, cakes and meals was much lower than at present, there was not that great necessity for arranging the diet with regard to strict economy as there is at the present time. There is no doubt that in the past, much cake and meal has been fed to waste ; in other words, the animal has been given more concentrated food than its powers of digestion could cope with. There is a limit to the amount of beef an animal can put on per day, and if richer food is given than is required for this, the excess passes out with the dung.

In the case of exhibition animals it is a different matter, because the aim there is to make as much live weight gain as possible, regardless of cost. But where it is intended to fatten at a profit, the ration must be cut as finely as possible.

Some recent experiments by Gilchrist and Bryner Jones, illustrate the same thing with regard to dairy cows.* They divided ten cows at pasture into two lots, and fed cake and meal to one lot and nothing extra to the other lot. The lot without cake and meal gave as much and as rich milk as the lot receiving none.

It is not intended to deprecate the judicious use of cake and meal, but probably in the future there will be greater economy in the use of such foods especially when the remainder of the diet is naturally good, consisting of grass, or hay, as in the case of the animals in Lot 2 mentioned above.

*Trans. Highland Agric. Society.

NOTE ON THE SHRINKAGE IN WEIGHT OF HAY IN THE STACK.

By B. N. Wale, B.Sc.

During last summer, the hay produced from some differently manured grass plots was weighed, and at once carted to the rick. As the weights per acre in some cases seemed rather high, viz., 43 cwts., it was thought desirable to find out what further shrinkage would take place in the rick. Accordingly an empty hop pocket was weighed, and then filled with the hay and again weighed. The pocket of hay was then stacked in the middle of the rick.

When the rick was cut into for stock, and the pocket exposed three and a half months afterwards, the hay was found to have undergone quite a normal fermentation; hence the shrinkage approximates to that which would take place under ordinary conditions as to weather and the degree of dryness of the hay at the time of stacking. The hop pocket was brought to light again on November 2nd, after being in the rick for fifteen and a half weeks, viz., from July 26th. The percentage of shrinkage is shown below :—

Weight of hay July 26th placed in the pocket ..	124 lbs.
Weight of hay November 2nd	102½ lbs.
Loss of weight	21½ lbs.
Shrinkage	17.33 per cent.

Hence one ton of hay ready for the rick would shrink nearly three-and-a-half cwts. under average conditions of fermentation.

LIVE STOCK DEMONSTRATIONS.

I.—FAT CATTLE.

By T. R. Robinson.

In pointing out the merits and demerits of live stock to those who have not had much previous experience with cattle, it is wise to go slowly, and not overdo the student with a mass of detail on the first inspection.

The instruction should also be frequent, and one of the great advantages of a well-stocked College farm adjacent to the College, is that the eye and the hand can be constantly kept in practice. Agricultural exhibitions and excursions to pedigree herds are most instructive and suggestive, especially to those who know something about the breeds they are invited to visit ; but for the vast majority of men, whether they are " born judges " or not, there is nothing like having the various types of the right sort of cattle at one's back door. The more completely the farm is stocked, and the greater the variety of stock, the more valuable is the knowledge obtainable. In most cases the attendance at these demonstration classes should be small, and if a ring, covered yard, or judging theatre can be had, and the animals are quiet enough to be paraded or held in the centre, so much the better. A weigh-bridge, preferably with a large dial, near at hand, is a necessary adjunct. Once more let it be advised to go slowly, and not confuse the men with too many objects which may come later under consideration.

A good course can be carried over the Agricultural year, the cattle-classes being arranged under the following heads :—

1.—Handling cattle from a Butcher's point of view.
2.—Judging cattle in the Feeder's interest.
3.—Score-Carding from No. 1.
4.—Dairy cows (*a*) Judging by inspection.
(*b*) Judging by records.
5.—Selection of Store Stock (*a*) Grazing; (*b*) Dairy.
6.—Judging cattle by Breed Points (Score Cards).

Fat cattle are put first, as they are the easiest for the beginner to handle, or at any rate more likely to appeal to his interest and imagination, which can often be excited by a previous lecture on the subject. Although Section 1 (fat stock) is the only one to which space can be allotted in the present article, obviously the more important part for the young farmer to get hold of comes under Sections 2 and 5, (*a*) store stock according to the time of year, as it is almost impossible to feed at a profit without a knowledge of the kind of cattle likely to do well. The autumn term is particularly adapted to the butchers' and feeders' demonstrations, the spring and summer sessions being devoted to the latter part of the syllabus. One need only mention that there are other live stock on a teaching farm besides cattle in order to show that there need be no lack of variety for anyone at all interested in the work. Besides the students, the stock and the necessary facilities, there comes the question of the instructor or instructors, for it can hardly be expected in these days of specialists, that one man can be an all round judge from Shires to shearlings. He must not only have the knowledge, but be able to express his opinions freely. There are some—and good men too—who know but cannot express themselves, and others to whom the reverse of this might be applicable. The combination of knowledge and the ability to impart it is essential to success. The first lesson in the ring, may begin with a short resumé of the lecture. The students should know the breed and characteristics of the cattle before them, also the ages, weights and feeding rations of the animals. The weight may first be guessed at, each man writing down his estimate. Doing this for several animals of a similar size will be found most useful. The instructor should then say the correct weight, explain what is meant by fasted weight, then get his men to convert the figures into Imperial stones, London stones, and scores. The markets to which these terms apply, together with the ruling prices should also be quoted, or written on a blackboard. Those parts of the animals known as first quality are then pointed out, such as the loin, the fore rib, the rump and the round ; the inferior parts being left to be spoken of subsequently.

Each student is now shown how to handle and compare the width and thickness of the lion and flesh over the ribs of several animals. This will probably be enough for the first inspection.

After demonstrations range over the two headings of butchers' points and indications of rapid fattening, before any attempt is made at scoring.

Taking the meat points in a systematic way the following plan has been found to work out in a practical manner.

1 The student stands directly behind the animal as is illustration No. 1. The fingers are over and the thumb just beneath the pin bones. He can then both feel and see whether the flesh is smooth and free from all patchiness, a fault which is very common with a certain type of cattle.

2 Taking a step alongside the animal he feels the thickness of the loin between the thumb and fingers, and secondly, using both, hands, the width of the loin.

3 The hand with the fingers held downwards is then passed along the ridge or dent of the back, noting any indentations or want of firmness. (This is done more with exhibition stock.)

4 With the palm of the hand the quantity and quality of flesh over the ribs is felt, and by taking hold of the skin between the ribs and hip its thickness and elasticity is tested. This will give one an idea of the quality of the animal, and how it is likely to dress out and scale when killed.

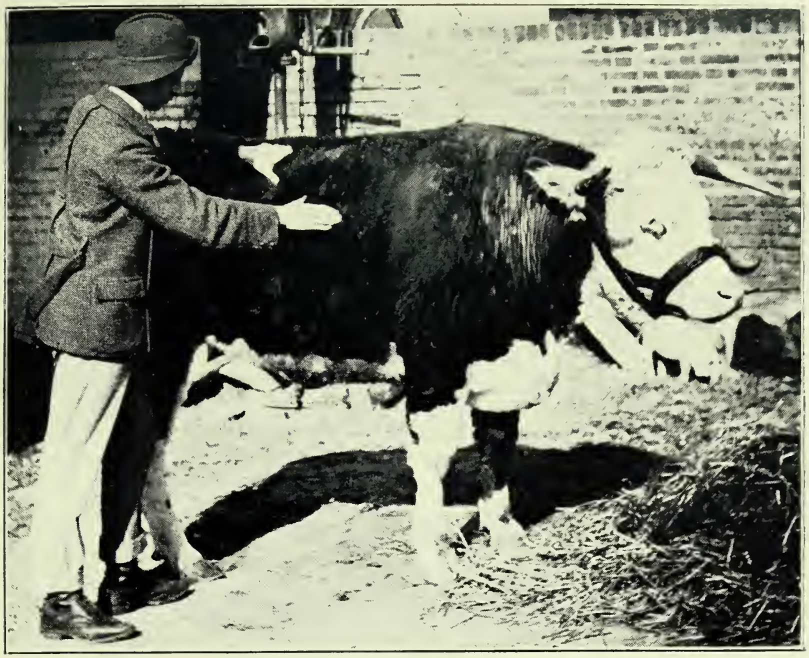
5 The width of the chine is now taken by placing the hand downward with the thumb extended on the other side. There should be no drop behind the shoulder, this is more important in a feeding, rather than in a fat steer. A weak girth may mean a poor constitution, or an animal more difficult to profitably fatten.

6 The neck-veins can now be conveniently felt (see illustration 3), also note is taken of the width of the breast, chest and neck. Again, this latter point is important to the feeder, and is always taken into consideration in judging a fat beast.

7 The flank (fig. 4) next comes under the hand, and much may be learnt from the flank; is it fat or lean, heavy or light? This again, taken in conjunction with other parts, helps one to judge not only the finished animal, but how the animal is likely to turn out.

8. The purse (a good test for fitness in a steer) can be felt by standing directly behind the animal. Its weight and fulness is said to be an indication of internal fat. Observation should also be made of the inner thigh or twist, the development of which adds very materially to the weight and value of the beast.

The word quality has a somewhat subtle meaning, but includes such definite points as freedom from coarseness about the bone and joints. A "feeding" head, the right sort of horn and ear, mellow skin and plenty of hair, and fine tail. The flesh should be evenly distributed all over the body, and the animal both able to stand and walk with freedom. It is however to the above eight points that it is wished to call attention. They are easy to remember when taken in the order named, and are the parts generally handled by the buyer. To avoid taking too much space, illustrations 2, 3 and 4 show two parts being handled at the same time. For teaching purposes it is advisable that each of these should be taken separately, in order to concentrate the mind of the student on that particular part. Corresponding points of two or more animals may be compared and discussed in order to bring out close observation.



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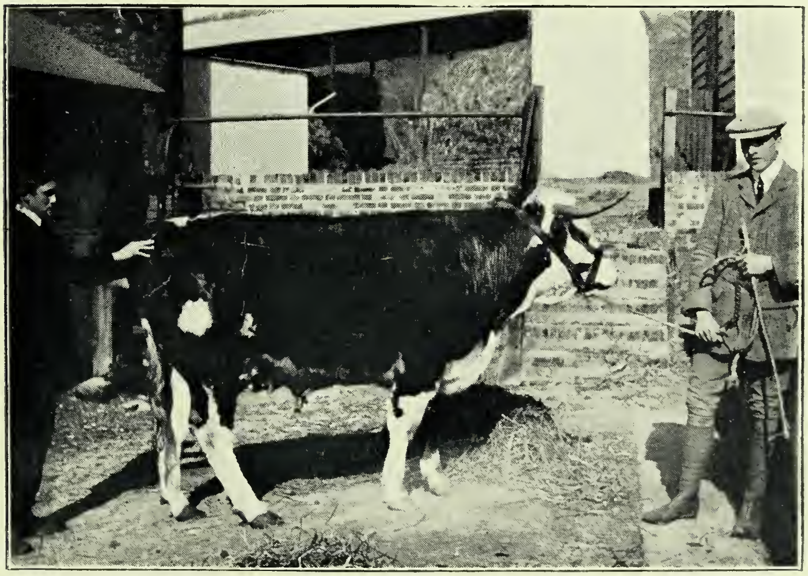

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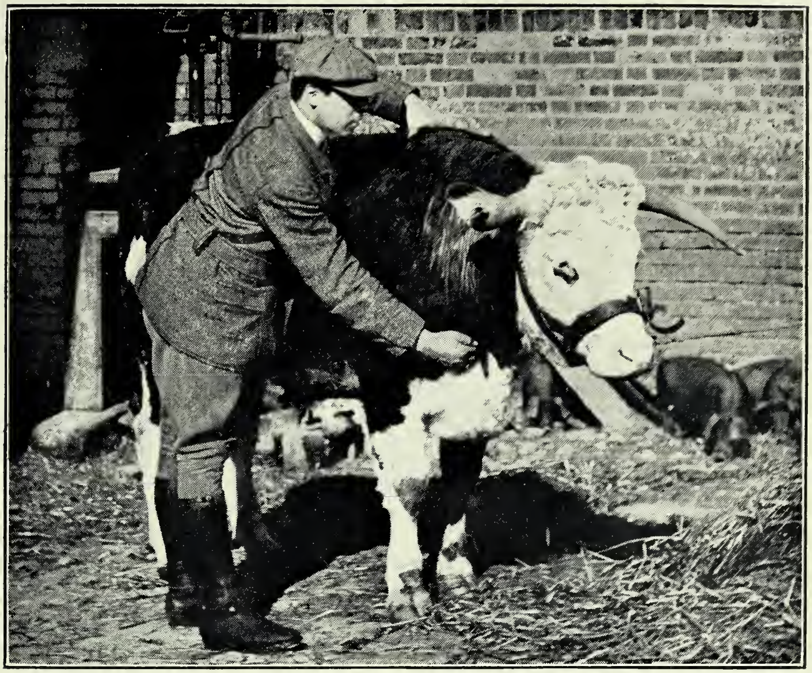

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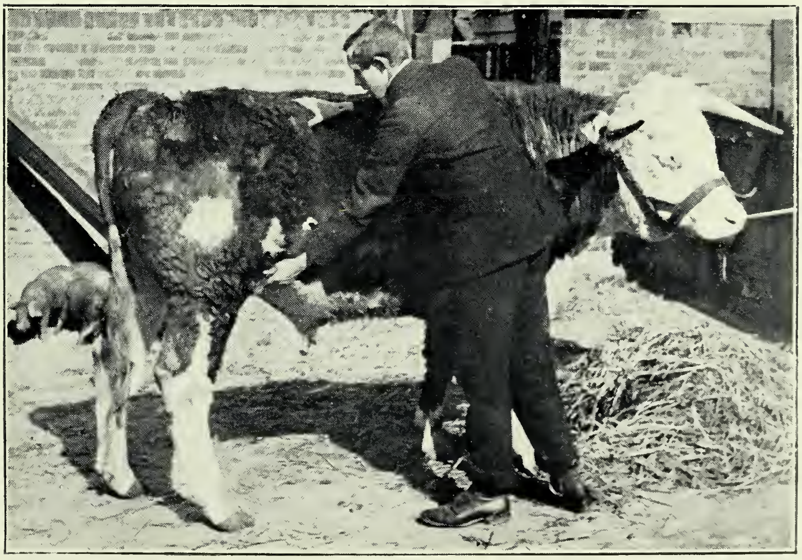

IV.

EXPERIMENTS ON TILLERING AND THICK *V.* THIN SOWING OF RED FIFE WHEAT.

By R. N. Dowling, N.D.A., P.A.S.I.

The Home-grown Wheat Committee of the National Association of Millers, had, after some considerable experience with Red Fife Wheat, ascertained that it gave very variable yields of grain and straw under different conditions, but in consequence of its maintaining such an excellent quality as regards strength (*i.e.*, the term given to define the power of certain wheat to produce a well piled loaf, always about the same, no matter how adverse the weather or other agents might be), the Committee thought it advisable to ascertain the conditions, as regards soil, position, etc., under which it might succeed as a farmers' wheat.

Seed was distributed over many parts of England, and was grown by farmers interested in the question.

At the end of the 1906 season, reports were made and sent in by each individual grower, showing very interesting results.*

It was noticed that the actual yield of grain per acre in certain instances far and away exceeded the estimated yield while the crop was standing.

This experience was so common that it was thought advisable to look into, and if possible, to ascertain the cause.

In my position as Managing Assistant to the Wheat Committee I was, during the harvest of 1906, able to closely observe some considerable areas of Red Fife and Square Heads Master Wheat growing side by side.

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* See Report on Red Fife Wheat, 1906, by the Home-grown Wheat Committee.

On this occasion, it was thought that Fife would be very much below the yield of the English wheat, the Fife having every appearance of being a smaller crop, not taking into consideration the smaller size of its ears.

After threshing out the Fife and Square Heads Master ricks, it became evident that there was very little difference in yield, the advantage being with the English, but nothing like the expected result.

To discover some information as to the cause on this point, thirty different one-foot lengths were marked off in various parts of the field, in both the Fife and Square Heads Master.

The stems or straws in the stubble were then carefully counted in each separate one-foot length and as an average it was found that stems per foot length in Red Fife numbered 44.8, whilst in Square Heads Master the average was only 29.4, thus showing some 50 per cent. more for Fife. The next thing was to find out how this thick plant on the part of Fife was caused.

Samples were taken from the threshed corn of the two different wheats in question. The grains were carefully counted, and the following results obtained :—

Number of grains in one bushel of Red Fife Wheat ..	694,983
,, ,, ,, Square Heads Master	567,831

this being about 22 per cent. more in favour of Red Fife.

Thus it will be seen that 22 per cent. of the 50 per cent. thicker plant of Fife was probably due to the fact of the smaller berry, and therefore the greater number to the bushel.

It is possible that the increased number of grains sown in a bushel of Fife over English wheat, may account largely for the increased number of stems, both because of more grains being sown and also because each grain had its chance of tillering.

The conclusion arrived at, however, was that Red Fife had tillered better than the English Wheat grown alongside.

It was then thought advisable to find out, firstly, the greatest extent of tillering of Fife, and secondly if thin sowing would increase the size of the ear.

An experiment on Thick *v.* Thin Sowing of Fife was organised and carried out on the S.E.A. College Farm during 1906-7.

A portion of No. 1 Field on Silks Farm was chosen for the work, the soil being a calcareous loam, and in good heart.

Four plots, each measuring a quarter-of-an-acre and one plot of half-an-acre in area were pegged out and drilled as follows :—

Plot No. 1 drilled at rate of 4 bushels per acre.
,, ,, 2 ,, ,, 3 ,, ,,
,, ,, 3 ,, ,, 2 ,, ,,
,, ,, 4 ,, ,, 1 ,, ,,
,, ,, 5 ,, ,, 2½ ,, ,,

Plots 1 to 4 were drilled six inches between the rows.

Plot 5 being twelve inches between the rows.

All the plots were drilled on November 13th, 1906. The weather at the time of drilling was rather unfavourable for this operation, but in spite of same, a good strong growth took place during the winter, and with the warmer weather of spring the whole lot went ahead very fast.

At the end of May, No. 3 Plot looked better than Nos. 1, 2 or 4, but Plot 5 was showing better colour and appearance than No. 3.

At the middle of June No. 5 was still looking the best colour, but Plot 4 was appearing very thick.

Very little rust was to be seen on any of the plots, but a little smut was noticed here and there. Earing was observed to be starting on June 13th.

On July 8th, the following report was drawn up on the conditions then present, each plot being examined very carefully.

See Table p. 52.

The points of interest in the above table may be summed up as follows, bearing in mind that such report was made while the crop was standing.

(1) The straw was thickest and of best quality, both at this time and later, on Plot 5. This would seem to be due to the extra space between the rows. Of the other plots the straw was best in Plot 4 and worst in Plot 1. showing that space enhanced the general quality.

(2) As the crop got thicker, so the straw became longer and spindly. In Plot 1 it was 4 ft. 5 in. to 4 ft. 9 in. long, whereas in Plot 4 it was 4 ft. to 4 ft. 6 in.

RED FIFE WHEAT EXPERIMENTS—1906–7.

	PLOT 5. 2½ bushs. per acre. 12 ins. between rows.	PLOT 4. 1 bush. per acre. 6 ins. between rows.	PLOT 3. 2 bushs. per acre. 6 ins. between rows.	PLOT 2. 3 bushs. per acre. 6 ins. between rows.	PLOT 1. 4 bushs. per acre. 6 ins. between rows.
Tillering - - -	very good	good	good	not quite	so good
Thickness of Straw -	very good for Fife	good	as get heavier	seeding, inclined	to be thinner
Length of Straw - -	4′ to 4′ 6″	4′ to 4′ 6″	4′ 2″ to 4′ 6″	4′ 4″ to 4′ 8″	4′ 5″ to 4′ 9″
Quality of Straw -	good	good	get thin	ner as seeding	rises
Length of Ear - -	3½″ to 3¾″	3½″ to 3¾″	3¼″ to 3½″	3¼″ to 3½″ but of small and	larger proportion sterile ears
Number of Florets -	9 to 10	9 to 10	9 to 10	8 to 9	8 to 9
How set - - -	(examined later)	set 2's and 3's			
Rustiness - - -	rather bad	rather bad	better than Plot 4	better than Plot 3	better than Plot 2

(3) The ears were certainly larger in the thinly sown than in the thick sown plots, the latter having numbers of small sterile ears.

This is shown by the fact that Plots 4 and 5 had ears of an average length of 3½ in. to 3¾ in., while the other plots average 3¼ in. to 3½ in. only.

Also Plots 3, 4 and 5 contained ears that showed an average of nine to ten florets on each side of the rachis, whereas the thicker sown Plots 2 and 1, only showed an average of eight to nine. This then seems to indicate that a thickly sown crop has smaller and more sterile ears than a thinly sown one.

(4) The "setting" of the ears, that is, the number of berries in each floret, was about the same for all plots.

(5) As the crop got thicker, so there were less signs of Rust. Plot 1 appeared cleaner than any, that is, freer from rust, and Plots 4 and 5 suffered the most.

The whole of the plots were cut on August 15th and 16th, 1907, each plot being kept quite separate at stacking.

They were subsequently threshed out separately, and the following interesting results obtained.

See Table p. 54.

The above tabulated results as to yields of grain and straw from the various plots, also calculated out to yields per acre, tell their own story, and there is little need for many remarks.

It will be seen that Plot 1 which was drilled at the rate of four bushels per acre, gave the highest yield both as to grain and straw and was a crop that any grower might have been proud of.

It will also be noticed that as the amount of drilling decreases, so the yield diminishes.

There is one feature that stands out prominently, and that is, that from Plot 4 where only one bushel was drilled per acre, a yield was obtained of 41 bush. 15 lbs. In Plot 3 two bushels were sown per acre, but we do not get double the yield obtained in Plot 4, only getting 47 bush. 55 lbs. and although up to a drilling of four bushels per acre an increased total yield was got, yet for each bushel increase at drilling, a decidedly less yield *per bushel* sown was reaped.

Such shows then that a larger proportional increase in yield

SUMMARY OF RESULTS OF EXPERIMENTS ON RED FIFE WHEAT AT SILKS FARM, WYE, 1906-7.

Quantity drilled per acre. 6 ins. between rows.	Size of Plot.	Size of piece cut from centre of each.	Yield from piece cut.			Yield per acre.		
			Whole Corn.	Tail.	Straw.	Whole Grain. Tail not included.	Tail Corn per acre.	Straw.
PLOT 1. 4 bush.	¼ a.	0.16 a. =25.6 p.	cwt. lbs. 4 79	lbs. 43	cwt. lbs. 7 42	3,294 lbs. =54 bush. 54 lbs. =6 qrs. 6 bush. 54 lbs.	lbs. 269	tons cwt. qrs. lbs. =2 6 0 10
PLOT 2. 3 bush.	¼ a.	0.16 a. =25.6 p.	4 44	33	6 98	3,075 lbs. =51 bush. 15 lbs. =6 qrs. 3 bush. 15 lbs.	206	2 2 3 24
PLOT 3. 2 bush.	¼ a.	0.16 a. =25.6 p.	4 12	23	5 91	2,875 lbs. =47 bush. 55 lbs. =5 qrs. 7 bush. 55 lbs.	144	1 16 1 15
PLOT 4. 1 bush.	¼ a.	=25.6 p.	3 60	20	4 88	2,475 lbs. =41 bush. 15 lbs. =5 qrs. 1 bush. 15 lbs.	125	1 9 3 18
PLOT 5. 2½ bush. 12 in. between rows	½ a.	0.32 a. =51.2 p.	cwt. qr. lbs. 7 2 10	32	cwt. qr. lbs. 11 1 14	2,656 lbs. =44 bush. 10 lbs. =5 qrs. 4 bush. 10 lbs.	100	1 15 2 5

of crop was obtained from the thin than the thick sown plot, such probably being due to the following causes :—

(1) The encouragement and promoting of tillering.

(2) Increase in the size of ears of wheat, and a greater development and maturity of side tillers.

(3) Greater number of florets present on such ears.

Plot 5 affords some interesting results. It will be seen that although 2½ bush. were sown per acre and 12 in. allowed between the rows, that a yield of 44 bush. 10 lbs. was obtained, whereas Plot 3 with a seeding of 2 bush. per acre and 6 in. between the rows, affords a yield of 47 bush. 55 lbs.

These figures are interesting, inasmuch as they are contrary to expectation. It was noticed that very little tillering took place between the rows in Plot 5. Certainly the plot was not hoed, as is often done when grown at a wide interval between the drills, and did not get the advantage to be derived from such operation.

It would seem, therefore, that grain placed at wider intervals *in the row*, as in the case of Plot 3, tillered better ; that is, each grain developed a greater number of stems, than when more space was allowed between the drills, but less space between the grains in the row itself.

Another experiment was carried out to compare the tillering porperties of Red Fife with those of an English wheat.

Unfortunately, the weather was very wet, and the land sticky at sowing, and such conditions were probably more disadvantageous to the welfare of Fife than Essex Conqueror.

During the 14th, 15th, and 16th November, 1906, rows of wheat were hand hoed in, each row being 257 links long and 6 in. from its neighbour. A definite quantity was hand sown to each row, each grain being carefully put in, and no two grains being left close together.

Thirty rows of Red Fife were thus sown at the rate of 2 ozs. of grain per row, which in the case of Fife was equal to one bushel per acre.

Fifteen rows of Essex Conqueror Wheat were sown in the same way, and 2 ozs. per row.

Also two extra rows of Fife and two of Essex Conqueror were sown in the same way with 2 ozs. of seed, the grain, however, being counted in each case.

Each row of Fife contains 1,530 grains; each row of Essex Conqueror contained 1,215 grains; each weighing 2 ozs.

Before harvest, the stems were counted in one row of each sort, the other row of Fife being badly worked by wireworm was rejected, the result being:—

Red Fife.—From 1,530 grains sown obtained 1,934 stems; that is, from 100 grains sown obtained 126.4 stems.

Essex Conqueror.—From 1,215 grains sown obtained 1,726 stems; that is from 100 grains sown obtained 142.06 stems.

The above results, therefore, show that from a similar quantity of seed sown in weight, Red Fife developed more stems, but that whatever the cause, the English Wheat in this instance had a higher per centage of tillering.

Lastly, twelve rows were cut from the Fife and Essex Conqueror handsown rows respectively. Such were carefully threshed in a specially constructed thresher, and afterwards weighed, the results being:—

Yield from twelve rows of Red Fife 38 lbs. grain; yield from twelve rows of Essex Conqueror 56 lbs. grain.

Thus showing a yield in favour of the English Wheat.

HOP SEASON, 1906-7.

The manuring of the College garden for the year was as follows :

Fifteen tons of London dung (.7 per cent. nitrogen, .5 per cent. phosphoric acid, .5 per cent. potash), and one ton of shoddy (4·5 per cent. nitrogen) were spread in autumn and dug in.

In March five cwt. fish guano and four cwt. (26 per cent.) superphosphate were sown and nidgeted in.

The hops made a very early start in April, but cold weather in the early summer checked the growth very much, so that the hops were somewhat short of bine.

Fly began to come early in June, and the garden had to be washed with the horse-washer altogether six times, and at picking there were still a few lice.

One hill was noticed to have several spots of mould as early as May 6th, and the garden was sulphured at once with a knapsack sulphurator, and later on with the horse machine ; at picking time the hops were quite free from mould.

The crop was most disappointing. The hops came nicely into burr, but owing to the absence* of male plants on the south west of the garden, they hung in burr for a long time and never grew out ; eventually six cwt. of hops per acre were picked and sold for 75s.

The English hops of this year were generally unsatisfactory owing to the cold, unfavourable summer ; the majority of samples were poor in quality and showed mouldy hops.

For the monthly rainfall see page 475.

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* See *Journal*, page 377.

VEGETABLE DEPARTMENT.

The cropping of the vegetable gardens has been on similar lines to last year. Three-quarters of an acre is now devoted to asparagus for market purposes, trials of bacterial inoculation with leguminous plants are being made, and some potato trials are also being carried on.

The glass houses are used for tomatoes, cucumbers, melons, winter-flowering carnations and pot plants. The following results were obtained with the Potato Trials in 1907 :—

TRIAL OF POTATOES IN 1907.

Plot 1.—Trial of about fifty varieties.

Plot 2.—Early and late planting.

Plot 3.—Sprayed and unsprayed.

Plot 4.—Shoots, thinned and unthinned.

Plot 5.—Ripe and unripe sets.

Plot 6.—Sprouted and unsprouted sets.

Plot 7.—Planting at various distances.

Plot 8.—English, Scotch and Irish sets.

The season of 1907 was a very dry one here, and many crops suffered severely ; this will account for the large number of small tubers in the crop.

Plot 1.—Variety Trial (50 sets of each).

Sender.	Variety.	Total	Ware.	Seed.	Chats.	No of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
Scarlett	Tyne Kidney	73	45½	16½	11	3
Scarlett	Table Talk	93	64½	20½	8	2
Scarlett	Million Maker	62	33½	16½	12	16
Carter	Monarch	25	15	10	—	10
Sutton	Ninetyfold	67	31	30	6	4
Sutton	Satisfaction	67½	50	12½	5	7
Cambridge University Farm	Colleen	66	19	24	23	5
Sutton	Abundance	91	57½	22½	11	21
Williamson	Colleen	99	45½	32½	21	1
Fidler	Invincible	47½	20	14	13½	4
Sutton	Harbinger	65	11½	19½	34	—
Daniel	Royal Norfolk	58	—	25	33	3
Deal	Excelsior	17	—	5	12	—
Sutton	Epicure	76	41	18	17	5
Williamson	Midlothian Early	61	26	18	17	2
Williamson	North Pole	60	32	13	15	8
Scarlett	Radium	76	42	18	16	—
Scarlett	Southern Queen	53	24	14	15	—
Deal	Seedling No. 82	39	15	14	10	2

*7 lbs.=1 ton per acre.

Sender.	Variety.	Total.	Ware.	Seed.	Chats.	No of diseased tubers.
		lbs.		lbs.	lbs.	
Sutton	May Queen	50	29½	10½	10	14
Scarlett	Russett Queen	68	29	18	21	—
Scarlett	Gold Mine	65	34	19	12	1
Scarlett	Ambrosia	21	8	6	7	—
Scott	Hy. Scott	8	—	—	8	—
Scarlett	Pink Eye	48	19½	13½	15	1
Scarlett	Midlothian Early	55	22	15	18	2
Sutton	Windsor Castle	69	34	16	19	3
Deal	Highlander No 1	59	25½	19½	14	2
Deal	Highlander No. 2	97	58	20	19	5
Deal	Seedling 28	21	10	6	5	2
Sutton	Superlative	50	32	9	9	2
Scarlett	Peacemaker	39	23½	7½	8	3
Williamson	Davies' Warrior	100	53	34	13	6
Deal	Nobleman No. 1	53	30	13	10	3
J. Brown	The College Kidney	69	38	19	12	1
Deal	Nobleman No. 2	58	42	9	7	4
Fidler	Charles Fidler	90	68	15	7	8
Fidler	Seedling 24	59	35	11	13	4
Scarlett	What's Wanted	54	28½	10½	15	—
Carter	Snowball	65	42½	12½	10	15

7 lbs.=1 ton per acre.

Sender.	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
Scott	Seedling No. 1	58	36	14	8	5½
Carter	Long Keeping	82½	52½	20	20	5
Carter	Royalty	67½	42½	20	5	—
Farish	A 1	91	54½	17½	19	—
Farish	B 4	65	42	12	11	—
Williamson	Conquering Hero	91	60	15	16	3
Scarlett	The Moat	58	39	10	9	3
Scarlett	The Premier	78	23	16	39	4
Scarlett	Triumph	75	49	13	13	11
Scarlett	Warrior	55	41	7	7	8
Scarlett	Northern Star	78	29	15	34	4
Scarlett	Hero	69	48	11	10	7
Williamson	Johnson's Diamond	88	46	22	20	—

PLOT 2.—EARLY AND LATE PLANTING (50 sets of each).

	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
	Up-to-Date, planted 15th March	67	47	12	8	5
	Up-to-Date, planted 1st May	43	14	12	17	23

*7 lbs.=1 ton per acre.

PLOT 3.—SPRAYED AND UNSPRAYED (50 sets of each).

	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
	Up-to-Date (not sprayed)	73	43	13	17	9
	Up-to-Date (one spray)	80	53	15	12	8

PLOT 4.—SHOOTS THINNED AND UNTHINNED (50 sets of each).

	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
	Up-to-Date (unthinned)	64	43½	10½	10	4
	Up-to-Date (thinned)	61	42	9	10	4

PLOT 5.—RIPE AND UNRIPE SETS (50 sets of each).

Sender.	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
Wallace	Ninetyfold (unripe)	52½	25½	14½	12½	1
Sutton	Ninetyfold (ripe seed)	63½	34	14	15½	1
Wallace	May Queen (unripe)	46	22	12	12	—
Sutton	May Queen (ripe seed)	41	18	11	12	2

7 lbs.=1 ton per acre.

PLOT 6.—SPROUTED AND UNSPROUTED SETS (50 sets of each).

	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
	Epicure (unsprouted)	47½	19½	13	15	1
	Epicure (sprouted)	66½	28	21½	17	—

PLOT 7.—PLANTING AT VARIOUS DISTANCES.

	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
	Up-to-Date (72 sets) 24 X 12	48	21	9	18	1
	Up-to-Date (50 sets) 28 X 14	52	20	12	20	3
	Up-to-Date (32 sets) 36 X 18	43	23	9	11	3

PLOT 8.—ENGLISH, SCOTCH AND IRISH SEED (50 sets of each).

Sender.	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
Own Seed	Eng.—King Edward VII	27	12½	7½	7	—
Scarlett	Scotch— ,, ,,	36	15	13	8	—
Williamson	Irish— ,, ,,	84	36	26	20	—

7 lbs.=1 ton per acre.

Sender.	Variety.	Total.	Ware.	Seed.	Chats.	No. of diseased tubers.
		lbs.	lbs.	lbs.	lbs.	
Own Seed	Eng.—British Queen	42	18	12	12	31
Scarlett	Scotch— ,, ,,	65	35	16	14	—
Williamson	Irish— ,, ,,	80	26	22	32	1
Kickhane	Irish— ,, ,,	86	27	25	34	—
Fidler	Eng.—Eldorado	19	9	3	7	—
Scarlett	Scotch— ,,	64	25	26	13	—
Williamson	Irish— ,,	84	27	28	29	—
Sutton	Eng.—Sir. J. Llewellyn	39	15	12	12	—
College Farm	Scotch— ,, ,,	56	20	20	16	—
Williamson	Irish— ,, ,,	65	32	19	14	2
Fidler	Eng.— ,, ,,	41	13	10	18	4
Own Seed	Eng.—Factor	67	41	11	6	8
Scarlett	Scotch— ,,	82	42	20	20	5
Williamson	Irish— ,,	73	28½	14	31	—
Fidler	Eng.—Northern Star	27	14	5	8	—
Scarlett	Scotch— ,,	97	35	20	42	—
Williamson	Irish— ,,	101	44½	23½	33	—
Fidler	Eng.—Duch. of Cornwall	40	26	6	8	2
Scarlett	Scotch— ,, ,,	43	21	10	12	—
Williamson	Irish— ,, ,,	90	48	22	20	14
Kickhane	Irish— ,, ,,	72	30	14	28	2

7 lbs.=1 ton per acre.

REPORT

ON

ECONOMIC ZOOLOGY

FOR THE

YEAR ENDING APRIL 1ST, 1908.

BY

FRED. V. THEOBALD, M.A.

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INTRODUCTORY NOTE.

During the year ending April 1st, 1908, about 3,000 communications were received.

The majority of these were in connection with the spraying of fruit trees.

Great sums of money have been wasted on haphazard winter washing, with washes which claim to kill everything, but which in reality are of little value. Growers and farmers should take with caution the statements that this or that preparation will destroy *all* insects either above or below ground ; no such thing is likely to happen any more than one quack pill can be made to cure all man's ills.

A few interesting diseases have been reported, notably an attack of the *Heterodera schachtii*, the cause of "nettle-head" in hops, on oats in Yorkshire ; the invasion of cherry plantations in Worcestershire by the Raspberry Weevil ; damage caused by one of the Aptera (*Entomobrya nivalis*), to hops in Kent ; the presence of *Argyresthia laevigatella* on larches ; the attack of *Dascillus cervinus* on grass in Ireland ; and *Nacerdes melanura* on woodwork at Wisbech. Amongst fruit great damage was done by Winter Moth larvae and Lackey caterpillars. Special papers are given on these. The Apple Sucker has been very abundant again, but has been checked to a considerable extent by lime and salt washing.

For the last two seasons a considerable amount of the Cherry Fruit Fly (*Rhagoletis cerasi*) has been sent over to this country in the late French cherries. This is one insect which may quite easily take up its abode here and cause endless harm, and it is regrettable to see that this serious pest has not been scheduled by the Board of Agriculture under the Injurious Insects and Pests

Act. Moreover, the presence of the disgusting larvae in the fruit tends to stop people eating our home-grown clean fruit, and thus damages the grower directly. No other country would allow all this infected fruit to come over ; it must be injurious to health as well as detrimental to our cherry growers.

Whilst this report was in press, another introduction has been brought to my notice, namely, the larvae of the Plum Fruit Moth (*Opadia funebrana*), which has been found in quantities in boxed French greengages. Some years it is common in Devon.

A number of communications received from abroad are not included in this Report.

My thanks must be expressed to Mr. C. O. Waterhouse, Professor Ritzema Bos ; Sir George Hampson, Bart ; Dr. Carpenter ; Mr. A. E. Shipley ; Mr. Spencer Pickering ; Mr. Robert Newstead ; Mr. Cecil Warburton, and Mr. Gimingham for help given me in naming obscure species of insects, etc.

F.V.T.

ANIMALS INJURIOUS
TO MAN'S DOMESTICATED ANIMALS.

The Water Snail (*Limnaeus truncatulus*, Muller).

Information concerning the Water Snail, which is the host of the Liver Fluke (*Fascicla hepatica*) in its early stages, was sought from Selkirk by Mr. Andrew Linton.

This snail has a very wide distribution, occurring all over Britain, France and nearly all European countries, Northern Africa, in Morocco, Tunisia, Algeria and also in Abyssinia, Canaries, Siberia, Amoor, Thibet and Afghanistan. It may be found at all elevations up to, at least, 2,000 feet.

The genus *Limnaeus* (Water Snails) comprises three common species in this country, namely, *L. truncatulus*, *L. peregra* and *L. stagnalis*. In neither of the last two will the young stages of the Liver Fluke develop. It is thus important to notice the distinguishing features of the host snail.

The three species are figured here. Fig. 1, which shows more clearly the form of each than any technical description; but we may particularly point out that in *peregra* the last whorl is swollen or bellied, and occupies a little more than three-fourths of the shell; in *stagnalis*, largest species, the spire is long and pointed; whilst the smallest, the *truncatulus* has a small spire and the last whorl about three-fifths the size of the whole shell.

The Water Snails are partially amphibious, being often found some little distance from the dykes, pools, rivers, lakes and mountain tarns, in which they live; they may even be found crawling up low trees.

They are very prolific and, to some extent, gregarious, and are subject to considerable variation; *L. peregra* having no less than fourteen distinct varieties.

The *Limnaeus truncatulus* deposits its eggs or spawn upon mud around ponds, ditches and streams. The ova are laid in batches of thirty up to one hundred; each snail is said to lay as many as one thousand five hundred eggs; they are united together in strips of a gelatinous nature. In about two weeks they give rise to young snails, which generally resemble the adults, but are paler and often semi-transparent. Soon after hatching they make their way into shallow water, and keep together in companies for some time.

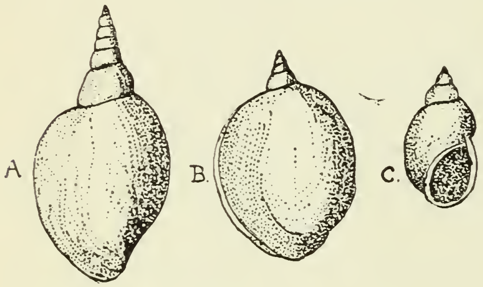

Fig. 1.

A. *Limnaeus stagnalis* (half natural size).
B. *Limnaeus peregra* (natural size).
C. *Limnaeus truncatulus* (slightly enlarged).

The embryo flukes seem to be able to develop up to a certain point in *L. peregra*, but never appear to enter the cercaria stage. This species of snail also lays its eggs in strings like the former, the number varying from twelve up to one hundred and eighty. According to Jeffreys as many as 1,300 may be laid in the season by each snail. As is well known the young stages of the Fluke passed in the snail are the so-called ciliated larva, sporocyst, redia and cercaria, the latter leave the snail and swim to grasses, etc., along the edges of the dykes, and there fix themselves, and turn to the sedentary so-called agamous cyst condition, which, on being eaten by the sheep, gives rise to the young "Flukes."

The Destruction of Water Snails is not an easy matter, but something may be done in this way.

The clearing of shallow pools of weeds and the removal of weed growth and mud from the entrance end of pools would certainly lessen the number of these mollusca, also the constant clearing out of ditches and dykes, and either the removal at once of the refuse or treating it with a heavy dressing of lime and salt.

Where artificial drinking wells for stock are made, it is advisable to have one end only open, so as to limit the space to be treated, such as we see in Gloucestershire, etc. But in damp, low-lying meadows, with rivers and dykes to contend with, the matter is much more difficult, and all we can do is to pay attention to the lessening of the breeding grounds mentioned above.

Warble Flies (*Hypoderma lineata* Villers and *H. bovis* De Geer).

At present there seems to be much confusion regarding treatment for the prevention of Warbles in cattle. The recently published report by Dr. Carpenter tells us that smearing the beasts to prevent egg laying is of no use, and from the very careful series of experiments which he has conducted, this seems to be the case in Ireland, at least where the experiments have been carried out. Just as has been observed in England, he found that the ova of *H. bovis*, the common Irish species, are laid on the legs and rarely flanks, seldom on the back ; this we have observed to be the rule with *H. lineata*. It is quite reasonable then to suppose that no good has been done by smearing the backs of cattle as was recommended by Miss Ormerod, if the smear merely acts *in situ*. The legs and flanks should be smeared and not the back and ribs. But the smears that have been used have often been strong smelling smears, and it is probably the odour that prevents the flies from striking the animals. That smearing does do good, we must acknowledge, when many large graziers find it successful.

Two cases reported to me are recorded here, and are of particular interest—one showing that smearing does no good, the other very conclusively that it does ! Writing from Iford, Sussex, Messrs. J. and H. Robinson say " We are every year very much troubled with the Warble Fly amongst our young cattle in the marshes. We have tried several preparations, one of train oil, sulphur, etc., recommended by Miss Ormerod, MacDougall's liquid, etc., but none seem very effective, they require such constant application as to be almost impracticable. Our marsh land has no shade, and our young cattle are punished terribly. We have taken Warbles out by hundreds this spring (1907). We have always followed Miss Ormerod's instructions and dressed along the back, and a little way down the sides of the flanks. If the eggs are laid as stated in the Board of Agriculture leaflet on the legs, then this is, of course, useless. We should very much prefer to prevent than cure this trouble, as to kill these maggots in the back of their host is very liable to make more trouble by the maggot rotting and causing a lot of water to form."

We would quite agree that smearing the backs is useless, unless the smell keeps the fly off. In any case it is more rational to dress the legs and flanks when we know the fly strikes there.

Another correspondent writes in very different strain from East Peckham. He says: "About five years ago I started applying to the backs of my dairy cows, with a whitewash brush, a mixture made of (1) Whale oil—one gallon; (2) Flowers of Sulphur—1 lb.; (3) Spirits of Tar—one quart. This was applied two or three times during June, July and August, and I believe the cattle rested a great deal better at pasture as a consequence. I now find that those cows smeared show no bots in the following spring, or at any rate only an occasional one, whilst my heifers which do not get done, owing to the labour of catching them in the meadows, show great quantities. The cowman is now so convinced that he wishes to have the heifers dressed also."

ANIMALS INJURIOUS TO FRUIT TREES AND BUSHES.

The Bark Beetle (*Scolytus rugulosus* Ratz).

Plum and pear trees were reported from Hurst Green Farm, Marden, attacked by this beetle. The presence of this insect can easily be detected by the small round holes seen in the bark. The larvae work between the bark and the wood, sculpturing out galleries on the latter. The beetles escape by the small round shot holes, so called flight holes. This pest was dealt with in the last Report.* It is not very common in Kent, occurring mainly in old and neglected orchards.

The Vine Weevil (*Otiorhynchus sulcatus* Fab.)

A request for information concerning the Vine Weevil (*Otiorhynchus sulcatus*), which was infesting vine and peach houses in the Isle of Man, was received in April from Mr. F. W. Ketley. He found them working at night as is the habit of the *Otiorhynchi*, and killed as many as sixty one night. The Raspberry Weevil (*O. picipes*) was also present, but the former was the chief culprit.

This beetle is sometimes spoken of as the Black Weevil. It is about two-fifths of an inch long, black with dull greyish hairs upon the head and thorax, reddish antennae and dark legs ; the wing-cases have deep furrows, with some pale dull ochreous hairs. As in all *Otiorhynchi* there are no wings.

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*Report on Economic Zoology for the year ending April 1st, 1907, pp. 17-20 (1907).

The beetles lay their eggs in the ground in July. The larvae are white and footless and somewhat curved, with a few pale hairs over the body. They feed upon the roots of various plants, including the strawberry, currant, vine, raspberry and may also be found in pot plants. The larval life lasts from the summer until March or April. Pupation takes place in the ground, and extends over a period of at least three weeks ; Taschenberg however, says fourteen days is the usual period in Germany. The pupa is dull creamy in colour, and has pale hairs of a rusty-red hue. It is found at a depth of about three inches, lying in the soil. The weevils seem to hatch some days before they emerge above ground and then soon commence to feed.

Like the other *Otiorhynchi* they feed mainly at night, and fall from the plant at the least shock, feigning death. It is fairly widely distributed over Britain, specimens having been sent me from Yorkshire, Derbyshire, Kent, Sussex, Surrey, Cambridgeshire, Devon, Middlesex and Huntingdonshire. Fowler records it as "local but common where it occurs ; apparently generally distributed in the London, Southern and Midland districts, and in fact as far north as the Northumberland and Durham districts ; but is recorded by Dr. Sharp as rare in Scotland, Firth and Tay districts ; Ireland, Dublin, Waterford, Armagh, Newcastle, and apparently generally distributed." It also occurs in America, Canada, Newfoundland and Nova Scotia.

They are best dealt with by trapping with moss or sacking and then collecting and destroying them in the daytime. Numbers may also be collected by jarring the plants attacked by the beetles at night over tarred sacks or boards.

The Strawberry and Raspberry Anthonomus (*Anthonomus rubi* Herbst).

This small weevil was found again at Wye during 1907, attacking the raspberries just as it did the strawberries. In June Mr. Harvey Bickham wrote me from Ledbury that he had found it working in his strawberry plots. " I found," he says, " a lot of the blossoms of the strawberry plants had died, and on looking closer,

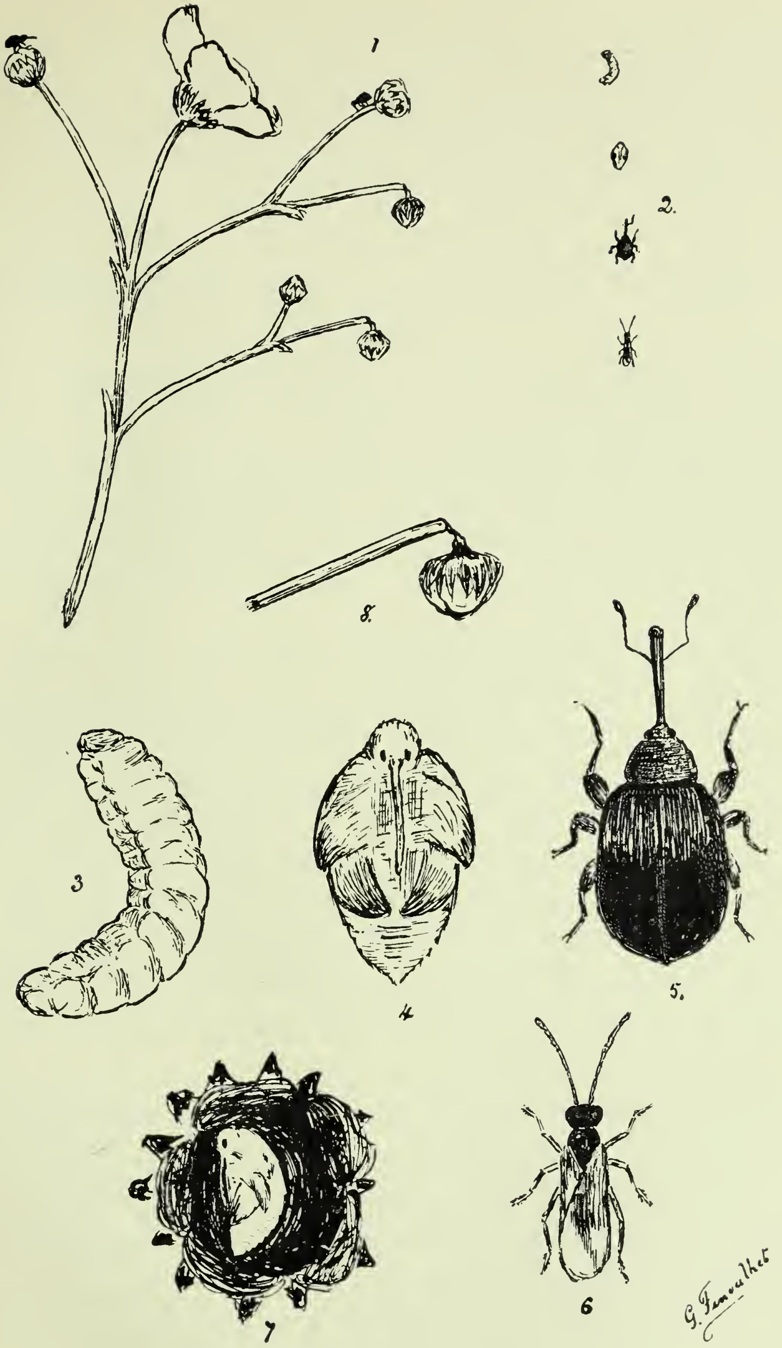

Fig. 2.
Anthonomus rubi. (Herbst.)
1, Beetles at work on Strawberry blossoms; 2, Stages life-size; 3, Larva; 4, Pupa; 5, Adult; 6, Ichneumon parasite; 7, Pupa in blossom; 8, Damaged blossom.

I found the stem just below the blossom had been punctured." Nothing further can be added to Mr. Fenoulhet's description of it in the last report (pp. 77-80), except that it seems to be more common on raspberries than on strawberries. It may be easily collected and destroyed on raspberries by jarring the canes.

The Raspberry Weevil (*Otiorhnychus picipes*) **attacking the Cherry.**

An interesting attack by the Raspberry Weevils on cherries has been observed in Worcestershire.

Writing on the 2nd of June (1907), Capt. Crane, of Oakhampton, Stourport, complained of his cherries being nipped off at the base of the stalk, and the leaves being eaten in places. This was put down to Winter Moth, but not many were found upon the trees on examination.

When visiting the plantations in May this year, I found enormous numbers of the Raspberry Weevil on the trees and collected around the grasses at the base of the trunks. It appears after enquiries were made that this weevil is known locally as the "Cherry Bug," and that it has been recognised as a cherry pest for some time.

Captain Crane had them collected, and found that by putting sacking on the ground around the base of the stems, the beetles sheltered there by day, and in this way great numbers were trapped and killed.

Apple Blossom Weevil (*Anthonomus pomorum* Linn).

This pest so far baffles all attempts at prevention and treatment. There has, however, been noticed an appreciable decrease where the trees have been washed with hot lime, and to some extent where the lime and salt has been used.

Mr. Newton Berry of Boughton, wrote saying this beetle was very bad in the plantations there in the summer of 1907. It is also very troublesome in the Sittingbourne area. Mr. W. S. Harnett, of Newington, writes that it and "Scab" are his principal enemies.

Mr. Harnett, however, found that the 200 trees he sprayed with lime and salt wash showed no decrease in these pests in 1907, but this year he reports the trees as being very much healthier. The effect of the hot lime or the lime and salt is, of course, only to destroy the hibernating quarters of the weevils, and so drive them away and to retard the opening of the buds, and so prevent a certain amount of egg laying.

The presence of "capped" blossoms was also reported as being very abundant at the Toddington Fruit Grounds by Mr. Martin. It was also reported as abundant by Mr. W. J. Gardner, of Pinvin, Worcestershire. Mr. Furley has noticed in the latter county that the lime and salt wash had apparently lessened its attacks. Certainly at Mr. Best's it must have checked them, for we found the weevils sitting on the lime-covered buds, in which they did not appear to attempt to lay eggs.

The Apple Sawfly (*Hoplocampa testudinea* Cameron).

The widespread distribution of this apple pest and its serious nature is now well known. In many districts it is far worse than the Codling Maggot, and, unfortunately, at present we know of no practical preventive, than can be applied on a large scale.

During 1907 it was especially recorded as injurious to Worcester Pearmains. Mr. J. H. W. Best wrote saying it was doing a lot of harm in July at Suckley, but, by that time it had pretty well run its course.

From the Maidstone district many complaints were made. Mr. Bensted especially mentioned it as attacking his Worcester Pearmains, and that he had had collected and destroyed over a bushel of fruitlets that year, and two or more bushels the year before.

Spraying has been tried with arsenate of lead this year, but it in no way affected this pest. It was thought that the larvae might be poisoned when entering one apple from another.

Some trees sprayed with tobacco wash, however, were cleared of this insect. Further trials will be necessary before anything definite can be said. It seems, however, that the tobacco wash penetrates into the holes made by the larvae, and makes the fruit obnoxious to them. It is hoped growers will try this next year as soon as any signs of the maggots' workings are noticed, to see if it proves generally beneficial. Several trees that were badly attacked last year had disulphide of carbon injected into the ground as follows :—

Tree (1) 4 ozs. of disulphide in four injections.
,, (2) 4 ozs. in twelve injections.
,, (3) 2 ozs. in sixteen injections.
,, (4) 8 ozs. in twenty-four injections.
,, (5) check.
,, (6) check.
,, (7) check.
,, (8) check

The injections were made in March. Two sawflies hatched out in No. 2 ; ten in No. 6 ; four in No. 8 ; none in any of the others.

The soil around the trees was covered over with canvas boxes, so that no insects could escape for four square yards around the trees.

Similar injections were made early in the autumn, and the larvae in the ground were destroyed where the injections were made four times to the square yard, when the soil was wet.

This method will be used on a larger scale next year as the result of the experiment points to this treatment being successful. The best time to inject the disulphide is October.

The Social Pear Sawfly (*Pamphilus flaviventris* Cameron).

This sawfly seems to be local, and only occurs now and again in sufficient quantity to do any harm. It was reported by Mr. W. F. Wood, from Chekes Court, Sittingbourne, and also by Miss Legg, from Amersham.

Besides feeding on pear, the " tents " of this insect may also be found on hawthorn. An account of it has been given in the College *Journal* for 1902.

The Plum Fruit Sawfly (*Hoplocampa fulvicornis* Klug).

The plum has long been known by practical men to be attacked by a large maggot, which we know to be the *Hoplocampa fulvicornis* of Klug, the *Tenthredo morio* of Schmidberger and Kollar.* During the last ten years the ravages of this Sawfly have certainly become more marked than formerly. Frequent complaints have been sent me from Worcestershire where, in the Evesham district in 1906, considerable damage was done to several varieties including greengages. From Ross, Mr. Getting wrote first in May, 1905, complaining of the damage and sending small plums, many of which showed the round exit hole of the larva. In June, towards the end of the month, he found many pierced fruitlets on the ground, but all the grubs had left them.† In June 1907, he wrote again complaining of a still further attack, and on more trees. In 1889, a Victoria Plum at Boughton was examined, in which every fruitlet had been struck, since that year the Plum Sawfly was not seen in the locality until 1907. In 1907, some prunes in the South-Eastern Agricultural College plantations were badly infested ; no trace of it had been seen before anywhere nearer than Boughton, some two miles direct. Ormerod‡ records it from Urchester in June, the observer mentioning that the plums were heavily attacked, quite half the crop being injured ; also from the Toddington Fruit Plantations, and also from the same locality in which complaints were made to me § in the Evesham district.

The damage is done to the young plums by the larva of this sawfly eating out the interior. If the attacked fruitlets are cut open, a pale larva at once seen to be that of a sawfly is detected within them. Later the infestation manifests itself more clearly by the presence of a round hole in each fruitlet whence the sawfly larva has escaped. The developing kernel seems to be their chief attraction, for in all I have examined this has been either damaged or completely destroyed. Fruitlets, from half to nearly an inch in length, have been found damaged. Ormerod says that those she examined from Urchester had usually one boring near the end opposite to the insertion of the stem. In all those sent me from

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* Kollar, V. "A Treatise on Insects," p. 268 (1837.)

† Theobald, F. V. "Report on Economic Zoology for the year ending April 1st, 1906, p. 54 (1906.)

‡ Ormerod, E. A. "Handbook of Insects Injurious to Orchard and Bush Fruits," p. 182 (1898.)

§ Theobald, F. V. "Report on the Orchard and Fruit Plantations."

Herefordshire and Worcestershire, and those found at Wye, the exit hole was at the side.

The opening is usually filled with wet frass as long as the larva is within, similar to what we notice in the Codling Moth. I have never yet found more than one larva in each fruitlet.

Although greengages have been especially mentioned as being attacked, it appears that all varieties of plums suffer, for we have seen it in Czars, Early Prolifics, Victorias, Blue Gage, Damson Plums and Pershores.

Kollar* says "the greengage and other round plums are attacked when they are hardly the size of a pea."

Life-history.

The Sawfly appears in April and May. In colour it is shiny-black with yellow, yellowish-red or reddish-brown legs, and iridescent wings, and with wing expanse of rather more than the third of an inch.

The female places a single egg in each unopened blossom, puncturing the blossom, according to Kollar, in the notched part of the calyx, making an oblique opening, and immediately introduces its egg into the deepest part.

The egg is very minute, greenish-white and transparent. It hatches in a few days (variously estimated from a week to a fortnight), and then the young larva forces its way into the embryo fruit and feeds on the developing kernel. When one fruit is damaged it eats its way into another. I found that the larvae sent me from Ross, some of which were nearly half grown, attacked three plums before they were mature.

The larva is creamy-white, in some cases having a faint pinkish tinge; the tail end is somewhat attenuated and the position usually slightly curved; the head brown; the six jointed legs are pale brown, and there are six pairs of pale pro-legs and an anal pair. When full grown the length is about one third of an inch, when expanded. The inside of the quite small plums are completely hollowed out, but in the larger fruitlets a space is merely shown around the kernel which the larva has devoured. This cavity is sometimes filled with moisture and "frass," but when the larva is within, is usually quite clean. No smell could be detected in any sent me, such as is described by Ormerod* ; possibly the specimens she received had lain together some time in the box, for it was noticed that where this was allowed the fruitlets became a wet putrid mass in a few days.

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* Kollar, V. "A Treatise on Insects," p. 268. (1837).

On reaching maturity the larvae leave the fruit, and enter the soil. Those received in 1907, pupated from July 17th to 26th, but in 1905, some had entered the soil by the 5th of the same month. In a few days I found they had spun small, roundish oval, brownish cocoons fairly close to the surface ; they were spun up in sand, and very difficult to detect, owing to the sand sticking to them, but the parchment like cocoon was brownish in colour. The larvae remain in these cases all the winter and pupate in February. A single brood only occurs. The sawflies like those which attack the apple are only seen on the wing in bright, still weather.

Prevention and Treatment.

There seems to be no way of preventing the insects from laying their eggs. It is advisable, when a single tree is affected in a garden or plantation, to have the whole of the fruitlets picked and burned, so as to stamp the insect out ; if this is not done, it may spread to the surrounding trees another year. All infested fruitlets should be picked up and destroyed at once. Land beneath trees which have been attacked might be dug over, well prong-hoed and heavily dressed with soot in winter.

No trials have been made but it is quite possible that a long sticking arsenical wash, such as Swift's Arsenate of Lead Paste sprayed over the young fruit would poison many of the larvae, as they bore into fresh fruitlets ; it is certainly worth a trial where this insect is very harmful.

On the other hand from observations made this year on the Apple Sawfly, no appreciable benefit was derived from spraying with arsenate of lead and Bordeaux mixture.

The destruction of the larvae in the soil has not been tried, but from the results obtained with di-sulphide of carbon on the Apple Sawfly at the College, and those obtained on the Peach Sawfly in America, it is more than probable that injections would destroy these plum pests.

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* Ormerod, E. A. "Handbook of Insects Injurious to Orchard and Bush Fruits." p. 152 (1898.)

The Lappet Moth (*Gastropacha quercifolia* Linn).

Specimens of the Lappet Moth were sent in January by Mr. W.F. Wood, of Chekes Court, Sittingbourne, found on apple. This handsome caterpillar also often occurs on plum and hawthorn and blackthorn. It hibernates when about an inch long closely attached to a twig or branch, and owing to its dull slatey grey colour, is difficult to detect. In spring; the lappet larva commences to feed on the buds and young leaves, and owing to their voracious nature and large size, very few will do a great deal of harm. When full grown the larva reaches about four or five inches in length. It is grey and greyish-brown, slightly hairy, with two large, violet to deep blue patches near the head end above, and flattish lateral processes like lappets just above the feet, and all along each side, with long grey hairs at their tips.

The cocoon is elongated and mouse coloured, and is spun up amongst the foliage or against a bough of the tree. The pupa inside is very active, and moves the whole cocoon with great vigour. The moth is very irregular in appearing, extending over a period from late May to August. The female is over three inches in wing expanse, the male is smaller, seldom more than two inches. The colour is a rich, rusty brown, with darker scalloped transverse bands on all the wings. It rests in a very characteristic manner, the hind wings projecting well beyond the front ones, which fold over the back.

The caterpillars hatch in September, and feed until the foliage gets hard, when they rest for the winter in the position described above.

On the Continent it is also recorded as attacking the peach. They are never abundant, but owing to their large size and ravenous nature they can do a great deal of damage. The ordinary spraying with arsenate of lead will destroy them, but owing to their size, hand-picking is usually resorted to.

The Wood Leopard Moth (*Zeuzera aesculi* Linn).

Damage by the caterpillar of this moth was reported by Mr. Gurney from Stanford, Biggleswade, an apple tree being attacked by it. Mr. Wm. Rogers also sent specimens from apple in April, from his plantations at Horton Kirby. In May, Mr. Newton Berry also wrote concerning its damage to an apple tree ; a whole bough was found to have its foliage and blossom withered up, and on opening it the white caterpillar spotted with black was found tunnelling right up the bough.

It is advisable to have any such diseased boughs cut off in May so as to destroy the larva and thus prevent further damage.

Cherry is usually its food plant. The most interesting note on it was sent by Captain Crane, of Oakhampton, Stourport, who found it tunnelling up the larger stems of the black currant in September. I have never known it recorded as doing this before.

Garden Swift (*Hepialus lupulinus*) **attacking Strawberries.**

A serious attack of the caterpillars of the Garden Swift Moth (*Hepialus lupulinus*) was reported by Mr. B. Champion, of Baron's Place, Mereworth, in April. The fields of strawberries were greatly damaged by the larvae, which devoured the roots near the crown, and so killed the plants.

Mr. Champion said that fields over three years old suffer most and the Royal Sovereign more than other kinds. The grubs eat large cavities into the root stem.

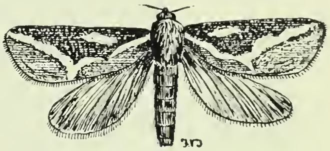


Fig. 3.
The Garden Swift Moth.

Besides the caterpillars of the Garden Swift, Mr. Champion also found larvae of a Bibio in the roots, some of which he sent in April. The main damage was, however, caused by the larval Swift Moth, which is one of our commonest moths.

Little can be done in such attacks but prong-hoeing in soot, which is most distasteful to the caterpillars. Great numbers of these were also found in the garden at the College Farm this spring, and it was noticed that at least fifty per cent were attacked by the fungus *Cordyceps entomorrhiza*, the mummified caterpillars, however, only in one case showed the large, upright spore receptacle so characteristic of this fungus. The artificial distribution of this fungoid enemy might be worth while as it certainly causes very heavy mortality amongst the *Hepialus* larvae.

It was hoped that specimens, last year, could be found at Mr. Murdock's, at Westerhill, Linton, where I originally found this fungus attacking the Swift larvae in 1896,* but the larvae had apparently dried out, and thus none could be sent to Mr. Champion.

The Gold Tail Moth (*Porthesia similis* Fues; *auriflua* Fab).

Always a common and widely distributed insect in Britain, and one with a very extensive list of food plants, but not so far, I think, recorded as damaging the fruit of trees. This was reported by Mr. Gurney from Stanford, Biggleswade, who found the caterpillars doing a lot of harm to the apple fruitlets, eating away the skin and just below it on one side. In many cases these wounds healed as seen in the specimens sent me, but of course, the apples were deformed, and practically valueless for market purposes. Many were quite ruined. Besides attacking young apples they also made serious inroads amongst the pears.

They may easily be destroyed by spraying with arsenate of lead.

The Vapourer Moth (*Orygia antiqua* Linn).

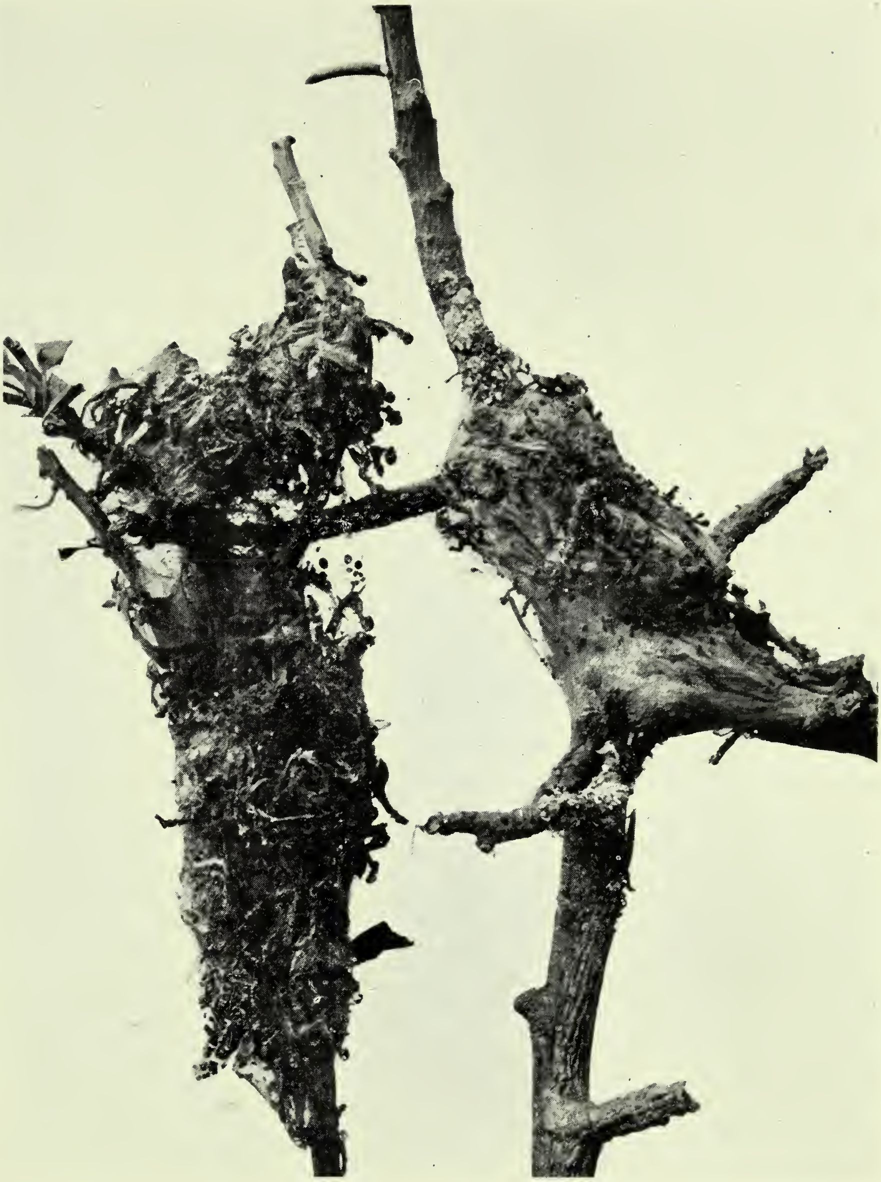
Quite a quantity of the caterpillars of this moth were found on fruit trees in 1907, and many egg masses were sent in during the winter.

Specimens of ova, from apple trees, were received from Brenchley, in January. The eggs are always laid on the cocoons by the females and as they are easily seen, they should be collected during the winter and burnt.

Other masses of eggs were sent from Leeds, Maidstone by Mr. George Charlton, from Bismark and Worcester Pearmain apples. These had been sprayed with Cooper and Nephew's V. i. fluid; they all hatched out in May, however.

Mr. Spencer Pickering finds that paraffin emulsion is fatal to these larvae.

* *S.E. Agric. Coll. Journal*, No. 5, p. 6, March, 1897.



[F. Edenden.

Fig. 4.

Tents of Lackey Moth Larvae (one-fifth natural size).

The Great Oak Beauty (*Boarmia roboraria* Linn) **on Apple.**

Early in February, Mr. John Riley, of Putley Court, Ledbury, sent some larvae found on apple trees during pruning, which proved to be those of the Great Oak Beauty. He saw no signs of any buds being attacked, but feared these larvae might do so. The caterpillars of this moth feed normally on oak foliage. They are greyish-brown ; with a pale spiracular line ; a subdorsal line spotted with black and white ; lateral projections on the sixth segment and a projection beneath the seventh segment. When mature, they reach an inch and a half in length. They are found from September to May, and hibernate on the boughs, shoots and bark of the trees. The moth appears in June and July. In size it varies from just about two inches up to two inches and a quarter in wing expanse. The front wings are whitish grey, dusted with dark brown and black, with darker serrated lines ; on the inner margin is a darker central line ; beyond it is a pale, brownish band, and before the hind margin another irregular, blackish line.

The moth appears in June and July. It is said to be rather local, and is recorded amongst other places from Lewes, Lyndhurst, Manchester, Tenterden, and West Wickham.

Its occurrence on fruit trees was probably only accidental.

The Lackey Moth (*Clissiocampa neustria* Linn).

A considerable amount of damage was occasioned last summer by the caterpillars of the Lackey Moth in the Sittingbourne and Faversham districts, and they have occurred again to a small extent this year. It has also been recorded from Smarden ; Messrs. Wood Brothers sent egg bands from Swanley, others from Ash, near Dover.

The Lackey Moth belongs to the family *Bombycidae,* which are more or less hairy moths: the males having pectinated antennae, the females thread-like ones.

This moth is widely distributed over the south, west and middle of England, but is most abundant in the south and west. It does not seem to occur further north than York, where it is uncommon. In the south of England it is always more or less common in our plantations, but at certain times it appears in enormous numbers especially in apple and pear orchards where it strips the foliage.

The vast concourse of them which appeared in the Sittingbourne and Faversham areas of Kent last year, carried all before them. Mr. R. Mercer, writing from Sittingbourne, says, "I have 100 acres of standard fruit that during the last ten days have been attacked by Lackey Moth caterpillars. At first the apple and plum trees were almost cleared of foliage; then they descended, travelled along the ground, and attacked the cherries. I have had about forty men and women putting paper bands covered with soft soap and tapping the boughs, which causes the caterpillars to fall off, after which they collect in enormous numbers on the stems of the trees below the bands. To show the magnitude of the attack, twenty to thirty bushels of caterpillars have been collected and killed. In spite of all that is being done, the loss will run into hundreds of pounds."

Carpenter * records it from Ireland. It is particularly common in France where there are laws compelling growers to cut off and destroy the "tents" and the larvae. Guérin Méneville states that it is one of the most injurious fruit and forest tree pests in France.

Kollar † gives an account of it and says that it is troublesome in Germany.

Unfortunately it feeds on hawthorn hedges and in woods, and being capable of moderate powers of flight, it is thus always liable to invade our orchards and gardens. It is thus advisable to pay small sums of money to school boys and others to collect the tents with the larvae from the hedgerows, etc.

Life-History and Habits.

The moth is very variable in size and colour, and measures about an inch in expanse of wings in the male, and an inch and a half in the female. The front wings are a rusty reddish-brown, varying to yellowish-brown, ochreous or brick-dust red with two pale or dusky transverse lines across them, the space between the two bars being often more deeply coloured than the rest of

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* Carpenter, G. H., "Injurious Insects, etc., Observed in Ireland during the year 1906." Eco. Proc. Royal Dublin Society. I. Pt. ii. p. 438 (1907).

† Kollar, Vincent. "A Treatise on Insects," p. 200 (1837).

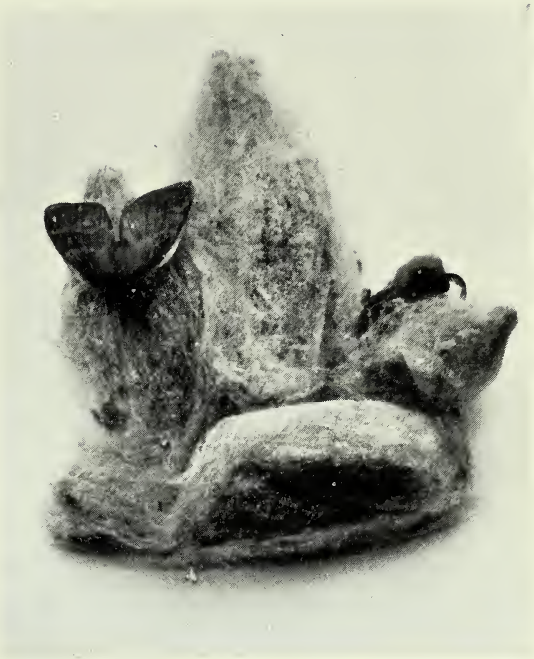

Fig. 5.
Cocoons and just emerged moths of the Lackey Moth.

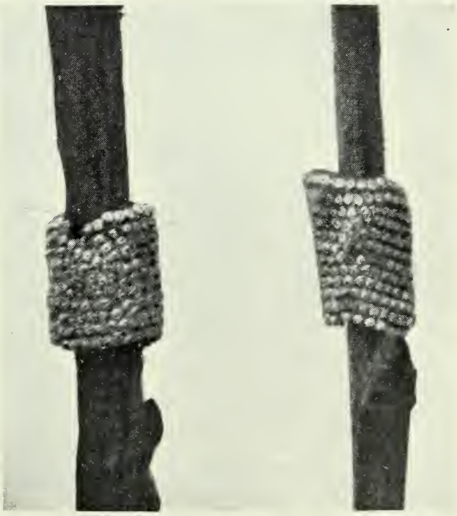

Fig. 6.
Egg-bands of Lackey Moth. (Twice Nat. size)

the wings; the hind wings are the same tint as the fore, but often a little paler.

The moths occur in July and August, and a few stragglers may be found in September.

The females normally deposit their eggs in rings or bands, usually choosing the year's growth of wood. Each band contains from forty up to two hundred eggs. The bands are shown in Figure 6. When the wood shrinks they may become quite loose and turn round and round, but at other times they may be found tightly gummed to the shoots. In colour they are dull grey to greyish-brown, and are on this account readily seen on the shoots.

Now and again I find them laid in irregular masses, not in rings, and so far as present observations go it seems that these are nearly always infertile ova.

From the middle to the end of April they hatch out. This year some larvae appeared on April 20th, and they went on hatching until May 10th, the latter date is, however, very late.

The young caterpillars are quite dark at first and hairy, the hairs of a rusty hue. Very soon they commence to form a web of fine silk, enclosing a few leaves, and beneath this they continue to feed for some time. As they grow the silken house is enlarged until it may reach over a foot in length. At first the larvae seem to feed entirely under the tent, but as they grow they spread out over the trees and feed upon the foliage, returning to their web at night and in dull wet weather. They become brilliant coloured as they grow, being bluish-grey, with two black spots on the segment next the head, and also two on the bluish-grey head; three orange-red stripes run along each side, and between the two lowest of these is a broad blue stripe with little black specks, these brilliant lines being separated by black and black spotted with blue; a pure white line runs down the back with a narrow dark line on each side; the whole larva has rather rusty hairs, which are darker above than at the sides. When full-grown the caterpillar reaches an inch and a half in length. On warm days they may often be found in batches, several lying parallel with one another, either on the outside of the tent or along the branches. They are somewhat timid, and fall to the ground on the tree being shaken, but soon crawl back to the foliage again.

Maturity is reached from the middle of June to the end of July, when they disperse and spin cocoons of loose pale silk, mixed with it are a number of hairs and a yellowish powder. The cocoons may be spun singly amongst leaves, on fences, etc., or, as seen in Figure 5, a mass of them may be spun together. In the cocoon the larva changes to a dark brown pupa, from which the moth hatches in two or three weeks.

The food plants are very varied, such as oak, elm, hawthorn, and roses being their favourites, besides the fruit trees previously mentioned.

Prevention and Remedies.

Many of the egg bands are naturally cut off by pruning, and these, of course, should be burnt. As the egg bands are very readily seen it would be advisable after an attack of Lackey Moth to go over the plantations, and see that all of them are destroyed in winter. Spraying with arsenical washes has been found of great benefit. Swift's arsenate of lead has been found excellent for these caterpillars. The trees should be sprayed in mid-May and again about two weeks later. An earlier spraying given for Winter Moth will also affect them unless followed by heavy rains. The early destruction of tents should always be done. For this we can use long handled pruners, and care should be taken to see that all the caterpillars are destroyed.

No winter wash will have any affect on these eggs. Some were left for some days in a mixture known as V. i. They all hatched out. A grower at Sittingbourne told me the same. It is scarcely likely therefore that spraying would have any effect on them, if soaking in the fluid did not.

Natural Enemies.

No insect parasites are of any value in checking the Lackey Moth. Of birds the only one that seems to feed upon the caterpillars is the cuckoo, which is well known to feed on hairy larvae, but they are not sufficient in numbers to do any appreciable good.

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* Theobald, F. V. Report on Economic Zoology for the year ending April 1st, 1907, p. 25 (1907.)

THE WINTER MOTH AND ITS ALLIES.

The Winter Moth (*Cheimatobia brumata* Linn.).

During the past year several very severe attacks of Winter Moth have taken place, and in several cases, very many acres of apples and plums were completely stripped of their foliage, and the result was not only loss of crop, but a serious set back to the growth of the trees. Two of the worst attacks were in the Sittingbourne area in Kent, and Ombersley in Worcestershire.

The present year has witnessed a still greater loss, and over a much wider area, for the damage has been severe in Cambridgeshire, Hunts, Suffolk, as well as in the counties of Kent and Worcester. This is most regrettable, as it is one of the few insect pests we can control. There is no doubt but that this persistent talk about winter washes destroying eggs has led to this. Growers have too frequently been led astray by people who imagine they can destroy everything with one wash.

Of all fruit tree pests this is one of the most harmful and widespread, but fortunately owing to its habits, we can not only keep down its numbers, but can almost exterminate it in our orchards by well-tried methods. It is needless to caution growers to take with caution any such statements as have been made lately that washes or spray fluids will kill the eggs of this moth or any other.

The Winter Moth takes its name from the fact that it appears late in the year. It is also called the Evesham Moth, on account of its having been noticed in numbers in that neighbourhood, but it occurs no more so there than in any other part of Britain.

The food plants are very varied: most forest trees, except conifers, are attacked by it, oaks often being completely defoliated. Of fruit it is worst on apple and plum, but it occurs also on pear, peach, currant and gooseberry, and now and again on raspberry, walnut, the rose, and other flowers.

The caterpillars are known as "Loopers" or "Measurers," on account of the means of progress, which is by a series of loops, the larva figured here being in an intermediate position. The family which contains this pest are known as the *Geometridæ*.

So great in numbers do these Loopers become that they often quite defoliate the trees, as previously mentioned, and later are known to attack the fruit, eating holes in the sides. When young they also damage the blossom and even buds.

One of the worst attacks was in 1868 and 1869, in the apple and pear orchards of Herefordshire and Worcestershire. In 1907 an enormous amount of harm was done in parts of Kent and in a few areas in Worcestershire. In the Sittingbourne and Faversham areas in the former county the trees looked in summer as if it were winter. Mr. Gardner, of Ombersley (Wors.), complained of the harm they were doing to his plums and were spreading below onto the gooseberries. This has been noticed by Miss Ormerod* from Kidderminster, and also from Gloucestershire, where they passed onto currants beneath the plums. So widespread is the attack of this pest that it is not necessary to refer to any further specific cases.

Carpenter† records the attack of this insect in Ireland in County Fermanagh.

Fortunately what we already know of its life-history goes a long way to place this enemy under our control.

The only unfortunate thing is that the Winter Moth also feeds upon various hedgerow and forest trees, and thus we are always liable to invasion if our plantations and gardens are approximated to woods, spinneys and ill-kept hedgerows. Nevertheless, owing to the peculiar structural character of the female the danger from this source is much lessened.

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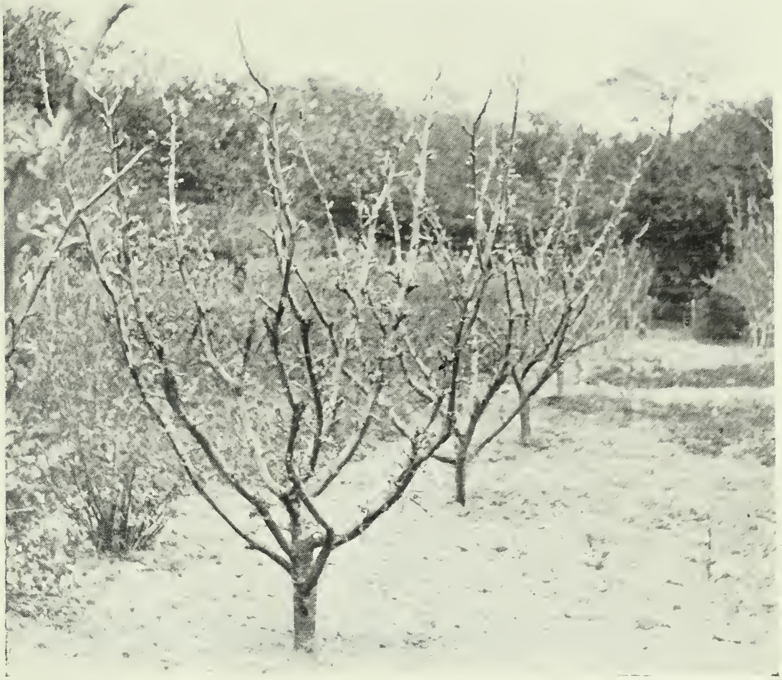
* Ormerod, E. A. "Handbook of Insects Injurious to Orchard and Bush Fruits," p. 179. (1898).

† "Injurious Insects and other Animals observed in Ireland during 1905." Eco. Proc. Roy. Dub. Soc., I. pt. 8, p. 329 (1906).



[*W. H. Hammond.*

Fig. 7.
Trees defoliated by Winter Moth.

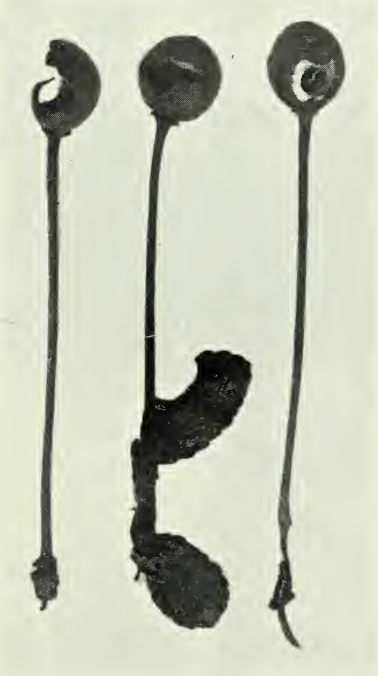


Fig. 8.
Cherries eaten by Winter Moth.

Some interesting new facts regarding Winter Moth were recently brought to my notice by Captain Crane, of Oakhampton, Stourport, when visiting Worcestershire with Mr. Furley in April last. The ova of the Winter Moth were seen by Captain Crane in great numbers laid on the trunks of the trees below the grease bands. They were very conspicuous, but were noticed to suddenly disappear. Careful examination showed the empty egg shells and the small larvae caught in hundreds in the grease bands, which had fortunately been kept in working order very late into March.

Life-History and Habits.

The male Winter Moth is a fully winged insect, although its flight is not powerful. In size it is about an inch and a quarter from tip to tip of the expanded wings. There is not much variation in size in the males, but in the females this is the reverse as is seen in the accompanying photograph (Fig. 9). The colour of the fore-wings varies between greyish-brown and brown, some few may show an ochreous tinge, marked with several transverse darker wavy lines varying in distinctness in different specimens ; the hind wings are of a paler uniform colour.

The female is greyish to greyish-brown in colour and differs totally from the male, having the merest traces of wings, which are always quite useless as organs of flight ; these remnants of wings sometimes show some ornamentation, the fore pair having two darker transverse streaks, the hind rarely a trace of a single one. There is some variation in size of these wing remnants, but none have been seen larger than those represented in the photograph. Miss Ormerod, gives a figure of them (F. Pests, p. 157), about two-thirds the length of the body, which must be very unusual judging from the thousands examined during the last twenty years.

The males have been observed for many years to appear some days before the females. From records kept it seems this date is on an average about ten days. They may be seen at dusk flying lazily along the hedgerows and in the orchards and gardens. They are attracted by light. One often sees them collected on street lamps, and they occur outside windows. This is a habit we may well bear in mind, for it is possible that we might trap them in very large numbers by light and thus prevent the fertilisation of the females.

The females crawl out of the soil from their cocoons and earthen cases. Nature directs them by one of her marvellous ways to the tree trunks, and these they ascend to deposit their eggs. As pointed out previously some oviposit on the trunks of the trees. Some have also been found in grass orchards crawling up the herbage, and it appears beyond doubt that some of these are carried by the males in copulâ ; the number thus carried is comparatively few.

The dates of appearance of the Winter Moth vary to such an extent that one can only give here very wide limits.

The earliest date I have record of, is October 1st, 1896, and the latest February 2nd, 1905. (A single specimen). This was on walnuts at Kingston-on-Thames. Their appearance on this tree is always later than on apple and plum. In some places they appear at one time, in others at another. For instance, during 1907, they were reported by Mr. Mercer, of Rodmersham, as covering the grease bands in November, whilst at Wye they were at the "swarming period" on December 17th. Six years ago the swarming period at the latter place was November 1nd. It is quite impossible to say when they will hatch out. The limits for practical purposes may be included between October 1st and January 15th. Frequently we have a few females straggling up some weeks before and some weeks after the main hatching. This again we must bear in mind, for a single female may deposit as many as 350 ova, enough, if they all hatched out into larvae, to defoliate a tree.

The females mainly seem to be fertilised during their ascent, but have been found in copulâ on the shoots. Whether the latter had been carried up by the males or not is unknown.

The ova are very marked. At first they are pale yellowish-green ; later they become brick-dust red. They are slightly elongate, truncated at each end, and have a distinctly sculptured shell. The position in which they are laid varies : some are placed around buds, some around the inside of pruned surfaces, others in crevices on the twigs and smaller boughs, and at others, on the trunks of the trees. Frequently they are well protected by the natural hairs of the shoots, mosses, lichens, etc. The shell is thick

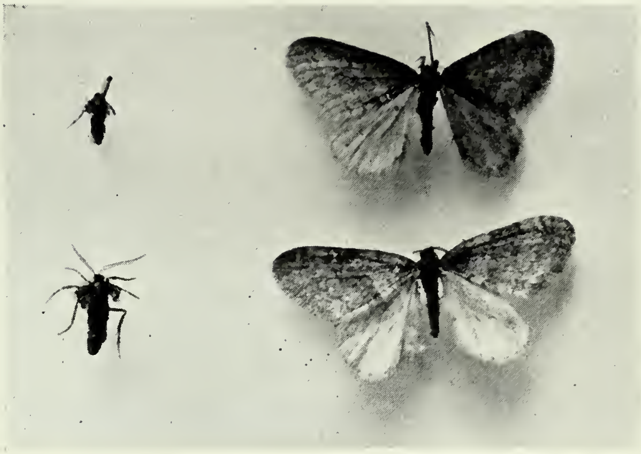


Fig. 9.
Females and Males of Winter Moth.

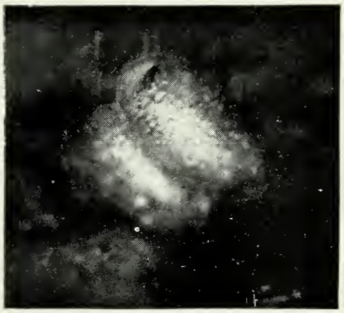
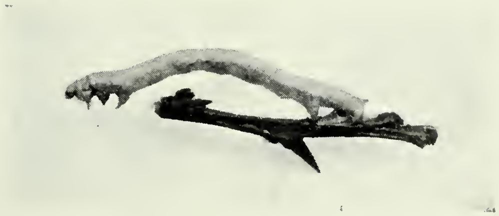


Fig. 10.
Ova of Winter Moth (greatly enlarged).



[*Edenden.*

Fig. 11.
Looper Larva of Winter Moth.

and is quite unlikely to be affected by any chemical that would not seriously harm the trees, if not kill them.

The period of hatching varies each year and in different localities. The old egg shells do not seem to remain very long on the trees ; they are shiny white, and soon crumble away. The small caterpillars usually hatch before the buds burst and at once commence to attack the young foliage as it opens. The minute loopers are at first dark in colour, and very difficult to detect unless they are moving. At first they feed freely on the small leaves. As they grow they become green with pale lines along their bodies : some are pale apple green, some yellowish-green, others dark green with the pale lines more prominent. The colour of the head also varies at different stages. When mature they reach an inch and a quarter or rather more in length, when fully expanded. The exact length must not be taken into account, however, as they vary so much according to their degree of extension. They are always much fatter than those of the March Moth, which is the only one they are likely to be confused with.

The habits of the Winter Moth larva are varied. At first, as explained, they feed on the opening leaf buds. Later they get into the blossom trusses and spin them together, and they may also spin two leaves together, living under the shelter they thus form. Before reaching maturity, they feed freely on the foliage again, and have been known to attack the fruit. This has been specially noticeable when they invade gooseberries growing under apples or plums. Cherries are also attacked by them. (Fig. 8.)

By the middle of June they are mostly mature, and then fall to the ground ; at least, we suppose so, for no one seems to have observed them do so. They all, nevertheless, reach the ground, and then the majority enter the soil to the depth of two or three inches. Having pressed out a small cavity in the earth, they spin an oval case of silk which becomes covered externally with particles of earth. In this silken and earthen case the "looper larva" having contracted considerably, casts its skin and becomes a brown pupa. This hatches into the male or female from October to early January, and the adult forces its way out of the soil. If in grass orchards, it is not unusual to find the cocoons, devoid, of course, of any earth, amongst grass and other herbage. The depth at which pupation takes place in the soil is very variable. If the soil is rough and cloddy, they frequently pupate under a clod of earth; if firm and compact, they enter the soil. All those kept in confinement have pupated from one to three inches, never deeper, and very few more than an inch below the surface.

Prevention and Remedies.

The prevention of this and the allied pests, the Mottled Umber Moth and the March Moth, is an easy matter. The process, namely grease-banding, is well-known to all fruit growers, and is firmly believed in and carried out by very many.

It must be borne in mind, however, that it is only these wingless females which are caught. Grease-banding has no effect upon such pests as the Lackey Moth, Figure-of-Eight Moth, Gold and Browntail Moths, Tortrix Moths or the Little Ermine, which have winged females. But where the Winter Moth and its allies are the culprits, then grease-banding is far better than relying entirely on spraying.

The bands should be made as follows :—First tie on the tree a band of good stout grease-proof paper, so that nothing can crawl beneath it ; then smear this over with sticky grease. There are several kinds of grease on the market for this purpose, and the grower will soon find out which has the most permanent sticky qualities.

The position of the bands adopted by growers varies. Some apply them high up the trunk, others low down. In the former case the reason given is that stock rub off the grease. It may be pointed out that when the bands are placed high up, many eggs have been detected laid on the trunk. In due course these hatch out, and the larvae will ascend to the boughs. It is best, therefore to apply the bands low down, about one foot from the surface. In bush plantations this can always be done, and it has been found that when placed so low down in grass orchards, sheep do little harm.

If this cannot be done, then we must keep the bands sticky up to the beginning of April, so as to catch the small larvae as they ascend, otherwise the banding can be only partially successful. Hundreds of the small larvae were seen in the bands at Captain Crane's, previously mentioned (p. 97.)

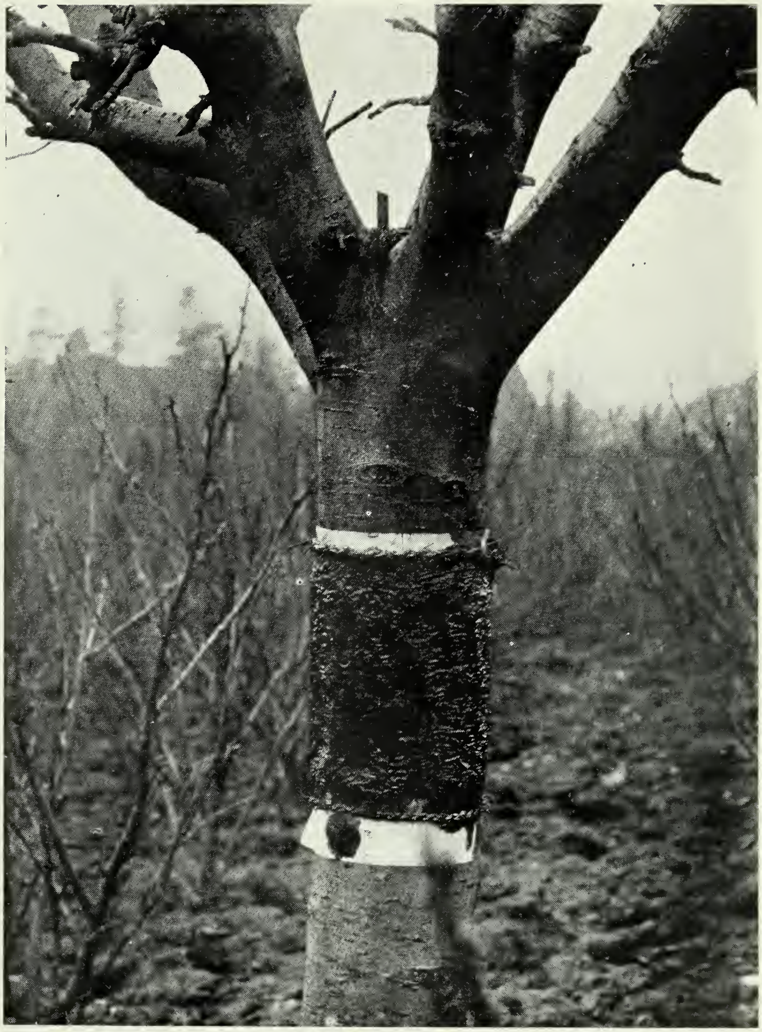


Fig. 12.

A Grease-banded Apple Tree.

Banded in this fashion many eggs will be found laid on the trunk below the band.

In young trees it is necessary to band the stakes as well, for the females will crawl up these as readily as the stem.

For the mature Winter Moth the banding should be in working order by October 1st, and should be kept going until the second week in January. It is no use to grease the bands once and then leave them. During the past year the writer visited a plantation in December, in which the bands were all dry ; a few days later the females were appearing in numbers, and thus for saving a small additional expense, all the money spent in banding the trees was wasted.

Moreover, the bands frequently become so smothered with insects that others can readily pass over their dead bodies. It is not only female Winter Moths that are caught, but the winged males in large numbers, and these aid very materially in covering the bands. Numbers of the Winter Gnats (*Trichocera regelationis*) also get caught, and many Midges and other flies, all tending to smother the grease, and so make a bridge for later hatched moths to cross. These covered bands should be cleared and smeared again.

The numbers of females caught on each band is frequently very large. Mr. Clive Murdoch writes from Linton that many of the bands contain one hundred females ; Mr. Mercer, of Rodmersham, that some three hundred were found on one band. Still greater numbers have been found by the writer on bands sent him from various parts of the country.

Mr. Ballard, Manager of the Eardiston Farming Company, near Tenbury, who follows this banding year by year, places a layer of cement around the large cyder trees to receive the grease. This plan seems to work very well, and does not harm old, rough and large trees, where ordinary banding would be very troublesome. In the Evesham district of Worcestershire, the practice seems to be to smear the grease directly on the tree. This plan is most injurious and very slovenly. Trees so treated were noticed to have the bark unhealthy.

The question is often asked if the eggs which escape from the ruptured bodies of the females caught in the grease will incubate. Great numbers have been kept during the past winter to see if this does happen, but not a single ovum developed ; the grease apparently soaking over them stops incubation.

Spraying for Winter Moth is often necessary where banding has been badly carried out, or where it has not been practised. For these caterpillars, Paris Green was once largely used, but owing to its so frequently scorching the leaves, many growers discarded it.

Arsenate of Lead is by far the best substance to use for this pest. We can now obtain this poison made up as Arsenate of Lead *Paste.*

One of the best paste forms seems to be Swift's Arsenate of Lead made by the Merrimac Company, U.S.A., and which can now be obtained in England from Messrs. Strawson's, and in Ireland from Mr. Watson, 61, South Great George's Street, Dublin, in 1-lb, 5-lb., 10-lb. and 20-lb. pails, 50-lb. and 100-lb. kegs.

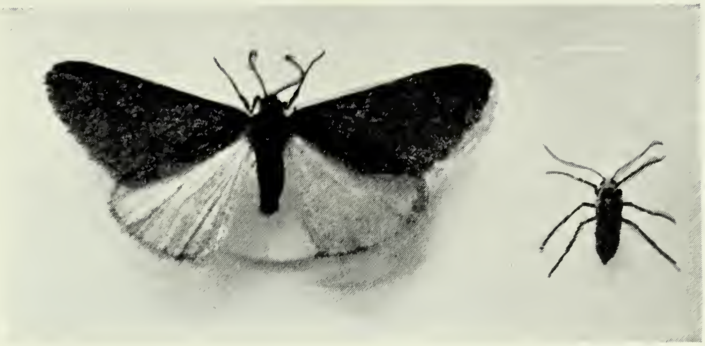
Those who prefer to make their own must see that the proportions are correct.

Mr. Spencer Pickering has found that the following formulae are safe :—(1) Arsenate of soda (pure or crystalline), 3½ ozs. ; acetate of lead, 7 ozs. ; water, 10 gallons ; or (2) Arsenate of soda (dry), 2 ozs. ; acetate of lead, 7 ozs. ; water, 10 gallons. The two substances should be dissolved separately in water and then mixed.

The arsenate of lead should be put on as a fine spray as soon as the leaves commence to show. The young caterpillars are then killed before they have done any damage. A second spraying is often necessary in the case of apples and pears ; this should not be later than ten days after the blossom has fallen. At this time any remaining Winter Moth, Mottled Umber and March Moth larvae are poisoned and also the Codling Moth prevented, and many other leaf eating forms at the same time are destroyed. The employment of poultry in a plantation is certainly very beneficial in regards to checking Winter Moth, and some growers have found pigs of equal benefit. It is not at all unusual to see the latter in Kent orchards.

The Mottled Umber Moth (*Hybernia defoliaria* Linn.)

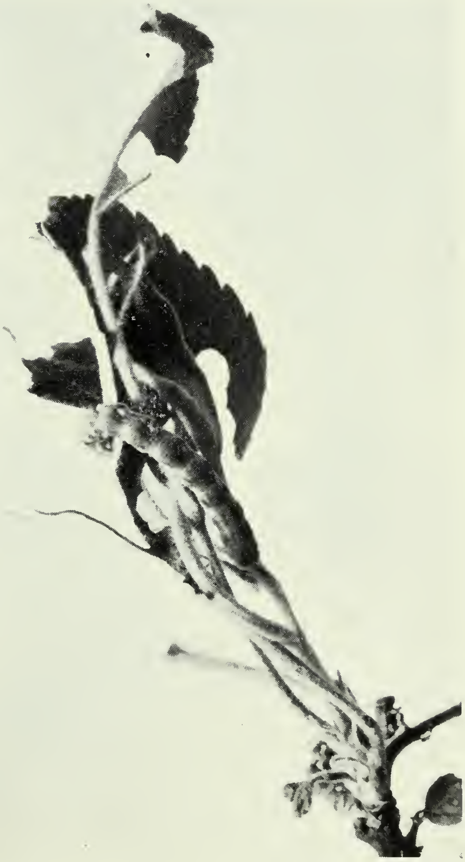
The caterpillars of this moth work in a similar way to those of the Winter Moth, but they more frequently attack the fruit. Mr. W. Bear forwarded some small apples in 1900, which had been



[F. Edenden.

Fig. 13.

Male and female Mottled Umber Moth.



[A. V. D. Rintoul.

Fig. 14.

Larva of Mottled Umber Moth and damaged foliage.

gnawed by these larvae from Harilsham. In 1902, specimens of similar damage were received from Yorkshire, and from a gardener in Nottinghamshire.

The damage to foliage is, however, of greatest importance.

Although generally distributed, the Mottled Umber Moth is not nearly so harmful as the Winter Moth. Nevertheless great damage is now and then done by it to fruit trees, especially those situated near woods of oak, etc. Mr. Paget Norbury, of Malvern Links, has several times written complaining of this insect, which was particularly abundant on his trees near some oaks, and some of which had been badly damaged, especially in 1905 and 1906.

It has also been sent me with notes of its destruction from many places in Kent, from Worcestershire, from Herefordshire, Staffordshire, Cambridgeshire, Huntingdonshire and South Devon. In the latter county, Major Vigors sent it from Whimple as doing damage to peaches.

The food plants are just as varied as those of the former species. Amongst orchard fruit may be mentioned apple, plum, cherry, pear, cob and filbert nuts ; of wall fruit both peach and apricot are attacked occasionally ; various forest trees such as oak, beech lime, elm and birch, and in hedgerows the whitethorn, blackthorn and privet. Cherry growers in Kent have often complained of it gnawing away the fruitlets, eating out round holes down to the stone. Specimens of this damage were also sent by the National Fruit Growers' Association in 1907, but no locality was mentioned, Many years ago Mr. Hammond sent me photos of oak and fruit trees stripped by these larvae near Canterbury. Owing to its larger size, when it appears in numbers it does relatively far more harm than the Winter Moth.

Life-history and Habits.

The male moth varies from a little under to a little over an inch and three-quarters in wing expanse. The front wings are normally a pale dull yellowish, mottled with yellowish-brown and dusted with brown ; there are two more or less prominent dark lines, the first bent in an angle, the second bent in three angles, and often followed by a darker line, and there is a central dark spot on each wing ; the hind-wings are of a more uniform yellowish-grey, with minute darker dusting and a dark spot on each.

The colour is, however, very variable, some specimens being dark rusty-brown all over, owing to the thick dusting of dark colour.

The female is quite wingless and plump, much larger than the female Winter Moth, of various shades of yellowish grey, and is much speckled with dark brown or black. Miss Ormerod * describes and figures the female with two black spots on each segment, but these do not show in any females I have noticed. The moths appear from the end of October onwards until the beginning of February. The females crawl up the tree trunks just in the same way as the Winter Moth. The ova are deposited on the buds and twigs, in bark crevices and on pruned surfaces.

The caterpillars hatch out later than those of the Winter Moth, usually in April. They are readily told from the Winter Moth by their colour ; the back is chestnut-brown or reddish-brown, and the sides a pale creamy yellow to bright yellow ; the venter pale yellow to pale greenish-yellow ; the spiracles pale with dark rims. Their means of progression is just like that of the former species. When mature they reach an inch-and-a-half in length. They have been sent by various correspondents as late as July, but most reach maturity at the end of June. They then fall to the ground and pupate in the soil.

The damage done by this caterpillar is twofold ; it attacks the foliage first and then later it eats holes in the young fruitlets. This is particularly noticeable where they are feeding on cherry trees, but many complaints have been received of similar damage done to apples and pears.

Prevention and Treatment.

The remarks made concerning the Winter Moth apply here.

The March Moth (*Anisopteryx aescularia* Schiff).

This is another member of the wingless female group. Although not so generally reported as a nuisance, it now and again does considerable harm to the plum and cherry, and has also been sent

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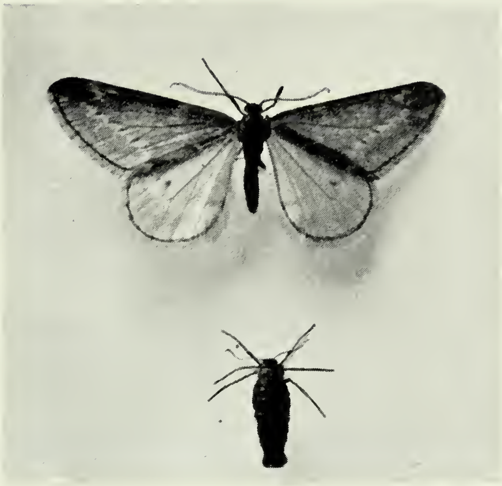
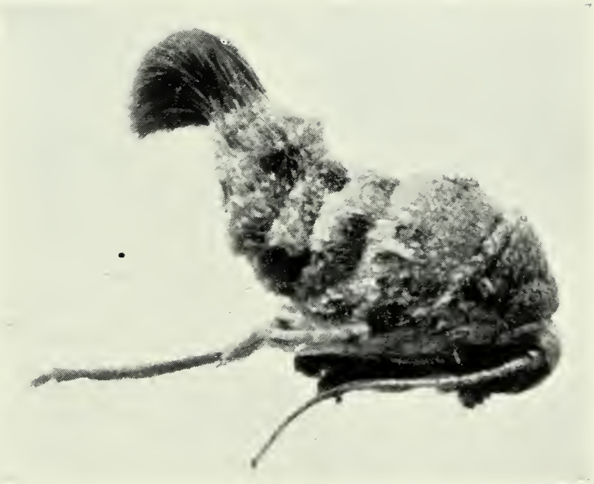
* Ormerod, E. A. "Handbook of Insects Injurious to Orchard and Bush Fruits," p. 179. (1898.)



F. Edenden.

Fig. 15.
Male and female March Moth.



F. Edenden.

Fig. 16.
Female March Moth, much enlarged to show tail tuft.

by correspondents from Surrey on apple and pear. Its normal food plants are the whitethorn and blackthorn; it also infests the oak, lime, elm, maple and walnut, and a few may be taken on the Spanish chestnut.

It occurs over a wide area from Scotland downwards, and has been reported as a fruit pest from Herefordshire, Yorkshire, Sussex, Kent and Middlesex. I have also seen it in abundance on plums in Cambridgeshire and in Yorkshire.

The popular name is derived from the date of its appearance. Specimens may, however, be taken as early as mid-February, and as late as mid-April, a few stragglers going on until the end of the month.

The wingless female is a very beautiful object.

Life-history, Habits, etc.

The male moth flies at dusk, and may be found in gardens, orchards, woods, and along hedgerows. The colour of the fore-wings is greyish-brown, with two dark and pale wavy lines running across as seen in the photograph, and there is a small dark brown spot near the upper border of each wing; the expanse varies from an inch-and-a-quarter to an inch-and-a-half; the hind wings are pale grey with a darker line, more or less continued from the outer line on each forewing.

The female is greyish to greyish-brown, with armour-like scales over the body and quite wingless, and has a very pronounced tufted tail of brown hairs. (Fig. 16.)

They crawl up the tree trunks just as the two preceding do. The eggs are often laid in a partial band, varying in size from one-quarter to nearly half-an-inch across; at other times, in a mass of irregular outline partially surrounding the twig; they are deposited in more or less parallel rows, and are embedded in brown hairs from the fanlike extension of the tail; the eggs are bright and shiny, and vary in number in each ring. Ormerod * records as many as five hundred in a ring; this appears to be exceptional, some fifty to two hundred being a wide limit.

The eggs hatch in April. This year, egg masses given me from Sittingbourne hatched on April 15th, and continued to come out for fourteen days. The small larvae rapidly emerge from the egg shells; some were timed, and were found to take less than a minute from the time the shell was eaten through until they were quite free, and then they soon spread about and were very active.

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* Ormerod, E. A. "Handbook of Insects Injurious to Orchard and Bush Fruit," p. 178. (1898.)

The caterpillar is bright green or green tinged with yellow (the latter I have particularly noticed when feeding on hawthorn) and somewhat paler between the segments; on the back is a narrow dark green line, edged with pale creamy white or grey; on each side are three pale lines, either white or grey; the head is uniformly green. The general form at once separates it from the Winter Moth larva, it being very slender and uniformly cylindrical, and about one-inch long when mature. In their young stage they grow much more rapidly than the Winter Moth, then growth seems to become slow. They mature by the end of June or early in July, falling to the ground, where they form a cocoon covered with earth very similar to that of the Winter Moth; the silk is of a dull yellowish hue, and very closely woven together. Porritt* mentions that caterpillars which hatched from eggs on the 3rd April, went to earth the middle of May. Many may be found in June, and I have taken numbers as late as the 7th July.

Larvae kept under observation fed particularly on the cherry blossoms, eating the anthers and pistil, and quite ruining them.

Prevention and Treatment.

The treatment is the same as for the preceding. Where this moth is prevalent, it is well to see that the grease-bands are kept in working order well into the end of March, especially on cherry trees, plum trees and damsons, so that the grease may remain sticky to catch the few stragglers that may come as late as the early part of April.

The Early Moth (*Hybernia rupicapraria* Hb.).

Now and again the caterpillars of this species are found in some numbers on plums, damsons and bullaces. The normal food plants are hawthorn and blackthorn.

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* Porritt, G. T., "Larvae of British Butterflies and Moths." Vol. vii., Pt. I., p. 157. (Ray Soc.)

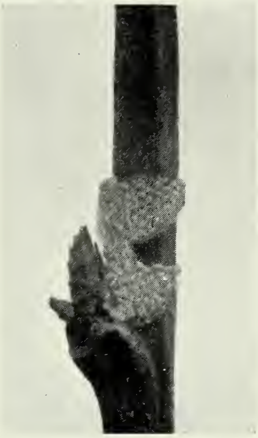
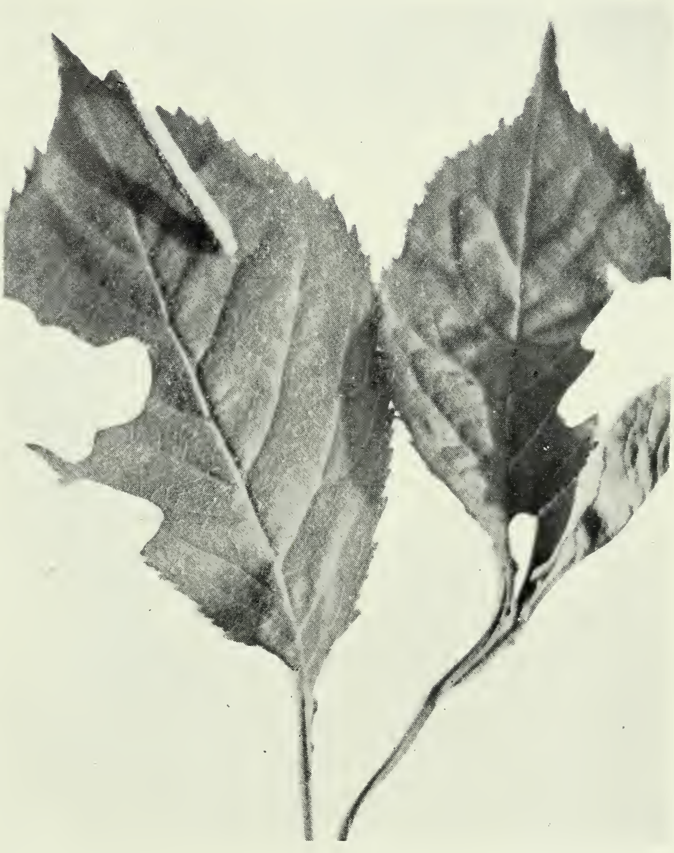


Fig. 17.
Egg mass of March Moth.

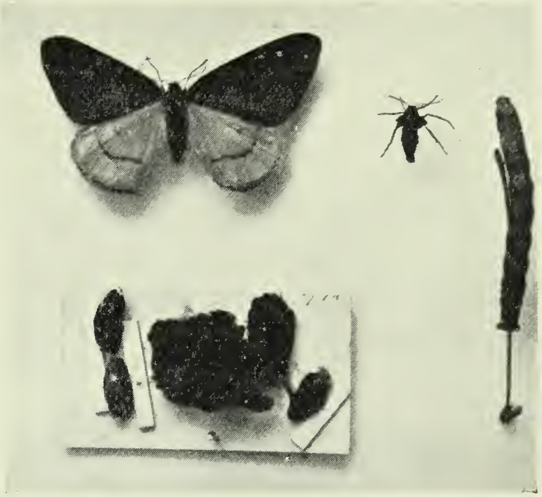


[F. Edenden.

Fig. 18.
Larva of March Moth and damaged leaves.

The moth occurs in January and February. The male has grey-brown forewings with a broad dark area across the middle, the edges darked and notched, with a dark spot in the middle; the hind wings are whitish-grey, with a dark central spot above the middle, and crossed by an indistinct dark grey streak; the wing expanse about an inch-and-a-quarter.

The female is almost wingless, the stumps of wings are greyish with a dark line on the front pair and a very slender streak across the hind pair. The caterpillar is green to bluish-green, with pale green back, the front of each segment darkened and a white line on each side.



[*F. Edenden.*

Fig. 19.

Male, female, larva and cocoons of the Early Moth.

When mature they fall from the leaves and pupate in the soil.

The moth is widely spread over Britain. I know of no records of it having caused any serious damage, but it has often been sent me from different parts of Britain with the preceding.

The Green Pug Moth (*Eupithecia rectangulata* Linn.).

Some shoots of Ribston Pippins were sent in April from Pershore, which were attacked by caterpillars. The chief culprit was the Green Pug Moth (*Eupithecia rectangulata*) and the Bud Moth (*Temocera ocellana*) to a lesser extent.

The damage done by the caterpillars of the Green Pug Moth (*Eupithecia rectangulata*) is far more widespread than is usually imagined. It is somewhat similar in its method of working to the Bud Moth, and has, in consequence, been frequently mistaken for it.

Stainton, in 1859, pointed out the damage done by the larvae in his Manual of Butterflies and Moths (Vol. II., p. 92), where he says : " This species is at times very injurious to the apple crop, the larva feeding in the young buds of the apple trees, devouring the stamens and pistils, and protecting itself by tying together the petals. Horticulturists who wish to get rid of this little pest are recommended to examine every bud which seems lazy in opening, as it will probably be found to conceal one of these mischievous larvae."

The larva is quite different from that of the Bud Moth (*Temocera ocellana*) being green with a central dorsal reddish-brown line and black head and legs. It reaches over half an inch in length, and matures in the latter part of May and early June. Those under observation spun up amongst the blossom trusses and some amongst the leaves. The moth appears in June and July ; this year those kept hatched on July 4th to 10th ; last year I took the moths in the third week in June. They rest during the day amongst the foliage.

The colour of the wings is rich dark green, the front pair with wavy transverse dark grey lines and slightly darkened at the tips in some specimens ; the size varies from five-eighths of an inch to a little over. Like the other Pug Moths, they rest with their wings expanded. Pear is also attacked by them, the blossoms being spun up in the same manner, and also to some extent the leaves.

Treatment consists of early spraying with arsenate of lead.

The Cherry Tree Stem Borer (*Semasia woeberiana* Schaff).

This pest seemed formerly to be confined to the Sittingbourne area, but it has either spread further afield, or it has been noticed more carefully. Mr. F. Smith, of Loddington, recently told me that it has occurred there for some years, so that probably it has always had a wider distribution on that side of the county than was imagined. It was also found working in some old cherry trees at Wye in February. Colonel Honeyball reports an attack at Teynham, and says that " this borer maggot which causes ' gumming ' in many cases kills the trees." He was paring away the dead bark as far as possible, and so destroying a number of the larvae.

As a smear, clay and arsenate of lead would probably be better than the tar treatment used by Mr. Lewis Levy. The larvae we noticed frequently eat through the tar, at Borden Hall; in eating through the clay and lead, many would undoubtedly be poisoned.

Psychidae on Apple Trees.

These quaint case-bearing larvae and case-bearing adults were found by Captain Crane to be in thousands on the stems of twenty-year-old apple trees at Stourport, and also on the crating of the trees. They are quite innocuous, feeding on the lichens growing on the trees and on the wood cratings.

The Pith Moth (*Blastodacna vinolentella* Schiff).

The Pith Moth has certainly increased during the last few years, and in 1907 the reports of its damage were more numerous than ever.

In May it was doing a good deal of harm on Lord Grosvenors, near Maidstone, also at Elmstone, Wingham, in June. It was also reported from Boughton, Linton, Greenhithe, Swanley and Sittingbourne. The only new interesting fact concerning it is that at Mr. Chapman's, at Greenhithe, it was widely attacked by some parasitic hymenoptera, which have not yet been identified. As many as ten of these little parasites hatched from a single larva, and they appeared to be very general in the plantation. They hatched out on July 10th, and are still alive at the time of writing.

Case Bearer (*Coleophora spp ?*) attacking Plums, etc.

A Case Bearer (Coleophora) which I was unable to identify, was sent by the Rev. F. Chambers from Chart Sutton in June, which was attacking plum leaves to a considerable extent. The method of working was very similar to that of the Pistol Case Bearer of the Cherry (*Coleophora anatapenella*), the lower epidermis of the leaves being left intact, the area being eaten away in small patches about the size of a pea, giving the leaves a spotted appearance. A large number of Coleophora attack fruit trees, but these at present have not been worked out.

The specimens sent from Chart Sutton were cigar-shaped and pale brown. Still more damage is done to apples by a small pistol-shaped Coleophora. These case-bearers can be found all the winter attached to the bark of the apple trees, some at the axils of buds and small shoots, lightly united by silk around the opening of the case. In spring they become active again and commence to feed on the opening buds ; young tender leaves have holes eaten right through them, and the petals of the blossoms are also attacked. The areas of damage on the tender leaves turn brown and present a very characteristic appearance. Quite a bad attack of this species was seen at Greenhithe.

The Pear Midge (*Diplosis pyrivora.* Riley).

Another bad year has to be recorded of this pest. From almost all the fruit-growing centres the same is reported, namely, a wider and wider spread of the fruit midge. A few notes of interest may be added here to our already wide mass of information we have of it.

In Kent they commenced leaving the fruitlets as early as the 31st of May, and continued to do so until nearly the end of June. Messrs. Caleb Lee, of Swanley, wrote that they were still leaving the pears on the 17th.

The most important thing noticed this year has been that in some cases the larvae were found as late as July 20th in pears, which had partially grown away from the attack, the fruits were quite three inches long and the live maggots were found in a small cavity near the head of the pears. Such is certainly very unusual, and such a peculiarity must be taken into account when dealing with the destruction of this pest. The fruit was certainly deformed, but not to a very noticeable extent.

Mr. Wakeley wrote complaining of its attack at Rainham, and stated that he was trying several experiments with the view to eradicating it. He now sends the following report, which he allows me to reproduce :—

" In answer to your inquiry as to the results of the experiments on Pear Midge, it is rather difficult to give any definite report,

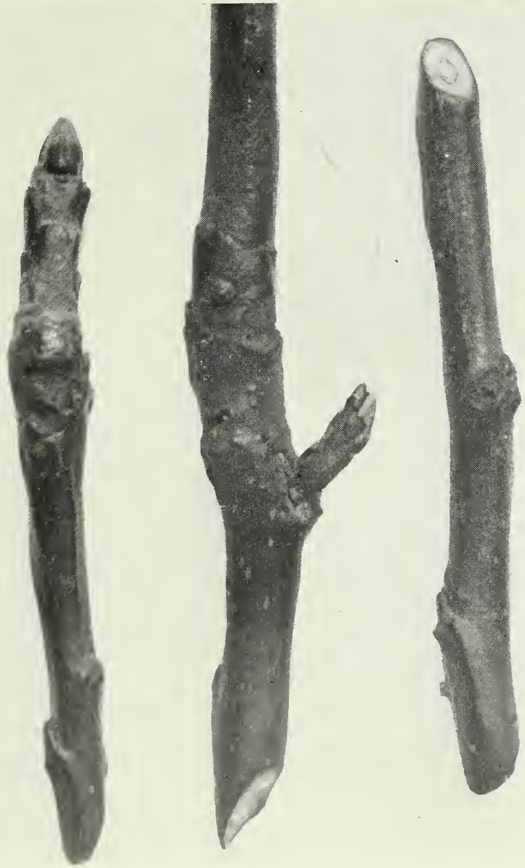
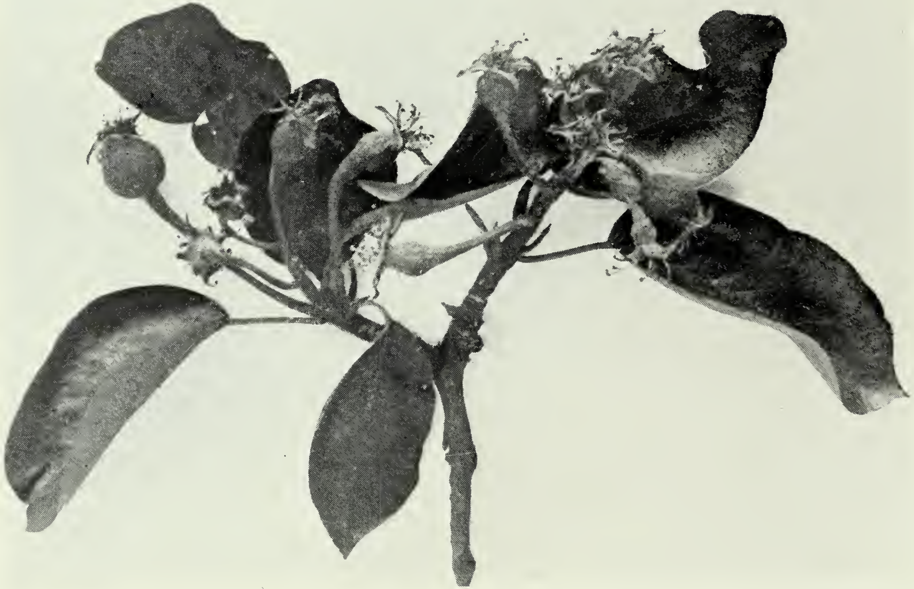


Fig. 20.
Winter quarters of Pith Moth.



[*F. Edenden.*

Fig. 21.
Pear fruitlets, normal and attacked by the Pear Midge (swollen ones)

excepting to say that the combined efforts appeared to check the plague and we have (*where treated*) a fair crop of Beurre Box and William Pears, although a fair amount of diseased pears were found, especially on the Williams, but the results are encouraging. In so many remedies on the same trees, it is difficult to say whether one thing was more effective than another, but personally I feel convinced that keeping pigs in the orchard through the winter and until the trees were in full blossom was the best thing. We also dug vaporite round the trees, and sprayed the trees on coming into blossom with weak paraffin emulsion, also sprayed the ground with strong emulsion at the time we expected the gnat to come from the ground.

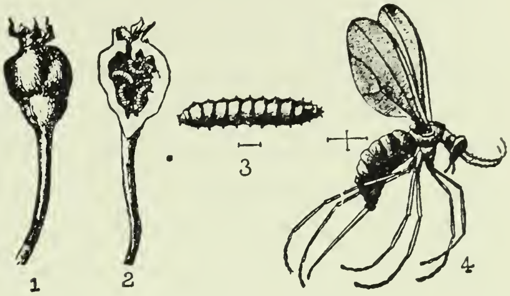


Fig. 22.

The Pear Midge.

1. Pear stunted and malformed by the larva within it. 2. Section of pear with larvæ. 3. Larva, much magnified. 4. Female fly, much magnified. Lines show natural length of fly and larva.

(From U.S.A. Dept. Agriculture).

"The pears are certainly better than last year where treated, at other places the Williams are a very poor crop, and suffered from the Midge as usual. The Beurre Box are certainly much freer of midge where we have the pigs for some months than they were in the same orchard last year." The use of paraffin emulsion to prevent egg laying has failed so often, we may discard this in these experiments, *pro tem.* The effect of vaporite, judging from some recent pot experiments, is varied, if put on thick enough so that the midge larvae actually come in contact with it they certainly are destroyed, but the fumes coming from it do not affect them in the least. Nothing but a thick layer under the trees, at the time of falling of the maggots is likely to be successful. This, however, would well repay doing if only growers in certain areas would all combine to do so. The benefit gained at Rainham was probably due to the pigs. The employment of these or poultry, undoubtedly, from what we know at present is the best preventive we have of checking this serious enemy. Captain Crane, of Oakhampton, Stourport, quite cleared it by the employment of poultry, and the same has been found successful at Wye.

Sciara Midges in Pear Blossom.

The small black midges belonging to the genus of Fungus Gnats or *Mycetophilidae* known as *Sciara* are often mistaken for the adult Pear Midge (*Diplosis pyrivora*). Specimens of these Flies were sent as Pear Midge from Chiddingfold, Godalming, in April, with a note that they were seen working in the blossom of pear trees. They can be told at once, however, from the latter by the wings having more veins, there being four, the third and fourth being bifurcate, whilst in the *Diplosis* there are only three, the third being forked only.

Cherry Fruit Fly (*Rhagoletis cerasi*) in Imported Cherries.

Writing last September Mr. Alfred Walker, of Ulcombe Place, mentioned that he had met with "a very unpleasant pest in the form of a small maggot (*Dipterous*), in the flesh of some bought cherries on June 15th (probably imported ones). They were only discovered by one of the party opening a cherry, which one rarely does; it put an immediate stop to their consumption, as most of the fruit was found to be similarly affected. I saw no outward signs, which will make the pest hard to discover." In another letter Mr. Walker says his wife remembers them in bought cherries many years ago.

In an old German book, "Gistel Mysterien der Insektenwelt" (1886) I find he says the following "*Trypanea cerasi* (Lin.) Schrk. Larvae im Fleische der Kirsche Fleyeschwärmt in Mai."

Another complaint was made from Ealing by a gentleman, who wrote that they were disgusted on opening a cherry to find a white maggot inside, and on examining others they found them mostly infected, and in consequence all were thrown into the dustbin.

During the last two years there has been a large amount of this maggot imported into this country in foreign cherries, especially the later consignments of French cherries. This year 1908 they have been more numerous than ever. The Cherry Fruit Fly is recorded as a British insect by Verrall, but on what authority I do not know. It certainly does not occur in the cherry orchards of Kent or Worcester.

This fly is one which might well live and flourish in this climate, and there is a very great risk of it taking up its abode here owing to this constant importation.

The only thing preventing it is that the majority of foreign cherries go to the towns, and the maggots are eaten with them.

Now and again they are noticed, and then other cherries are cut open to see, and the result as mentioned on p. 112 is that they are thrown away—here lies the danger of its introduction into this country.

It has another way of doing damage otherwise than to the individual cherry. There is not the least doubt that these disgusting creatures found in the foreign fruit put people off buying our home-grown cherries. It is very difficult to detect fruit that has been attacked by this fly until the maggot is nearly matured, then a bruised rotten spot appears. The only way to stop its importation would be to stop all importation of the late French cherries, they not only damage the sale of our own, but they are a standing danger as long as they come over as this year badly infected with this fruit fly.

There is little possibility of the Fruit Fly (*Ceratitis capitata*) scheduled by the Board of Agriculture living in this country except in hothouses, in peaches and nectarines, but there is every possibility of the Cherry Fruit Fly taking up its abode here, and we know of no satisfactory remedy for this pest.

The Peach Aphis (*Aphis amygdali* Fonsc).

The Peach Aphis (*Aphis amygdali*) is of frequent annoyance both in the open and under glass.

From Charlwood, Surrey, it was reported in June as affecting all the trees, which were badly covered with the lice.

It can be easily kept down under glass by fumigation with tobacco or pyrethrum, and out of doors by spraying with tobacco wash.

Red Leaf in Apples.

This disease is caused by the Aphis known as *Aphis sorbi*, the Rosy-leaf Aphis.

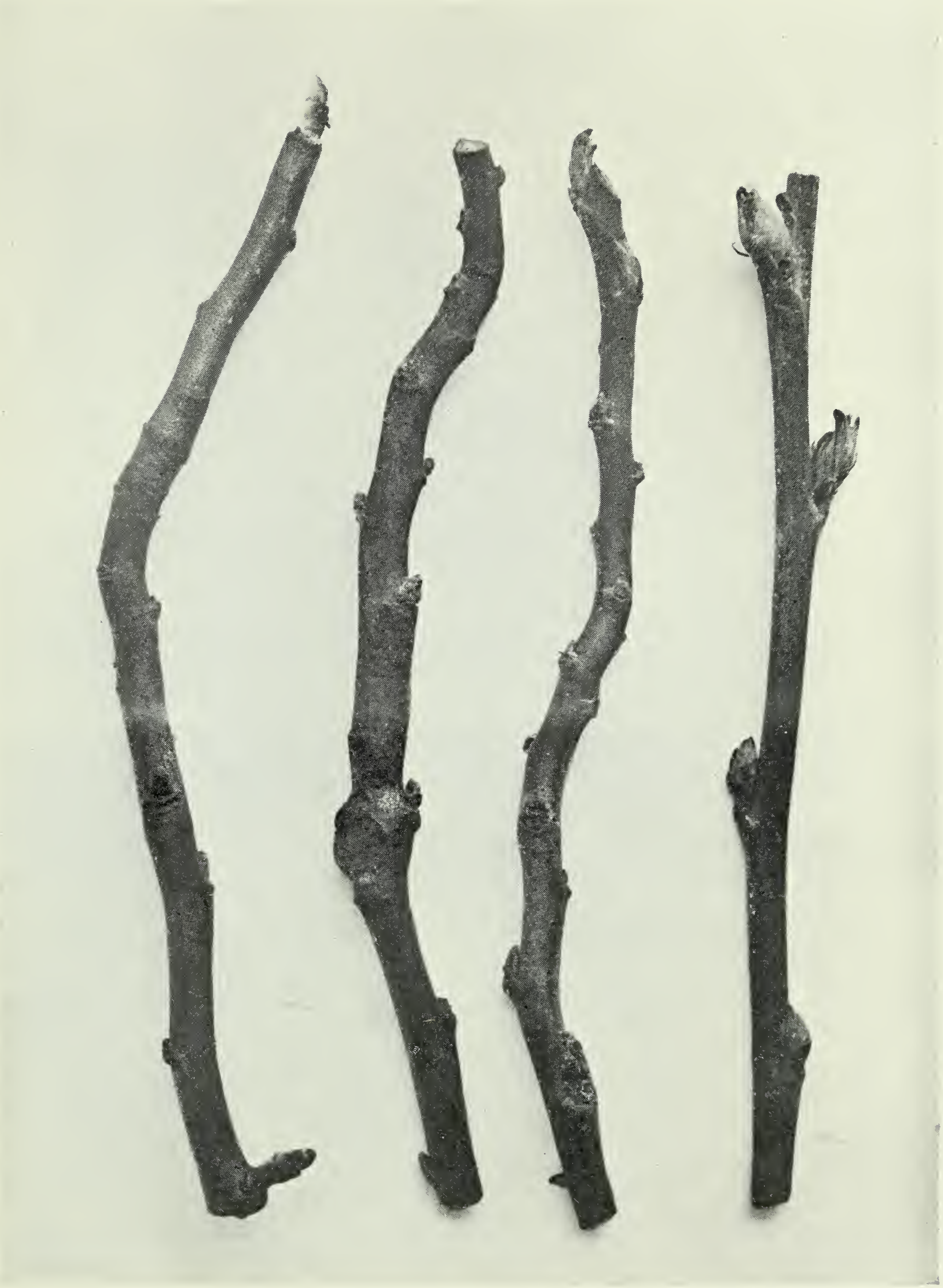
Mr. H. Reader sent me specimens of the damage with the following note in June, " I am sending you specimens of the apple leaves and wood which have been attacked by what we call ' Red-Leaf.' The variety is the Wellington, others that have it badly are Golden Noble and Stone Apple."

It has for some years been very bad at Pike Fish Farm, Yalding, the trees looking bright red, owing to the great numbers of curled discoloured leaves. Mr. Henry Reader was advised to spray in the autumn with strong paraffin emulsion, as much as seven gallons of paraffin to the 100 gallons of wash, and then with quassia and soft soap in May. This was done and Mr. Reader reports this year as follows :—

" We washed all trees that were affected by this pest the last week in October (1907) with a heavy paraffin-emulsion, as recommended by you. We used six barrels of paraffin, and the work was done thoroughly. In the spring it was found that some varieties had been cleared of this pest but a few had not."

The Apple Aphis (*Aphis pomi* Fab).

On November 7th, Mr. Wm. Bear sent some apple shoots covered with Aphis, these proved to be *Aphis pomi*, the ovigerous form. Many eggs had been laid during transit ; many ovigerous females were also still on the leaves. By the 15th all egg-laying ceased, the shoots being black with eggs. I could not find one laid on a leaf, in spite of the crowded masses on the wood. Some fifty or more females occurred on one leaf. Half these eggs as an experiment were dipped in Cooper and Nephew's wash known as V.i., the other half were kept (four shoots of each). Quite half the eggs on the dipped and undipped shoots shrivelled up. In early April the little green lice appeared just the same on the dipped shoots as on the untreated. They were dipped for five minutes in the wash sent to the College by Cooper and Nephews.



[*F. Edenden.*

Fig. 23.

Damage to Apple Shoots.

The three left hand shoots damaged by *Aphis pomi*, the right hand one normal.

A number of twigs covered with the ova of this Aphis were sent in March by Mr. Barker from the plantations of the National Fruit and Cider Institute at Long Ashton. The trees from which the eggs came had been sprayed with V.i., and Mr. Barker said "the eggs do not seem to be seriously affected." As a matter of fact a greater percentage than usual hatched out.

Deformed apple shoots were also sent by Miss Eve from Chichester, where the Aphis was causing harm in a nursery.

Numbers of eggs on shoots were also received from Wisbech.

The Mealy Plum Aphis (*Hyalopterus pruni* Fab).

A very late occurrence of this pest was recorded from Scotland. Writing on November the 9th, Mr. G. Sheriff, of Carronvale, Larbert, Stirlingshire, said "My principal trouble is with plums, our plums have been a complete failure for the third year running. The leaves are covered with green fly."

On the 14th of November a number of plum shoots were sent which were literally alive with *Hyalopterus pruni*. Winged females were appearing, and even at this late date they were producing living young.

The plum leaves were in their last stage, and must soon have fallen. The question is where do the winged viviparous females place their young at this late date.

Do they produce one of the ground forms of Aphis, in such a way as Barsacq (*Le Jardin*, xxi., 498, p. 348, November 20th, 1907) describes in connection with *Schizoneura ulmi*, which he says leaves the foliage of the elm and descends to the roots of currant and gooseberry bushes where it has been mistaken for a distinct species, *Schizoneura fodiens*.

This pest was also recorded from Worcestershire and Herefordshire; it was comparatively scarce in Kent.

Liver of sulphur added to the paraffin emulsion is necessary to destroy it.

The Woolly Aphis (*Schizoneura lanigera* Haus).

This apple pest continues to increase every year, but 1907 witnessed some exceptionally bad attacks all over the country.

The important point to bear in mind is that we may easily introduce it into clean areas with new stock. Mr. W. C. Brown, writing from Appleby, says, " I have never had Woolly Aphis until the last two years. I unfortunately bought some young trees from Nottinghamshire, and they also sold me the blight. I cured it on the young trees last season, but, alas ! it had spread to the older trees."

Its presence on the roots is becoming more widely known now, and growers are alive to the fact that it may be easily spread on the roots as well as on the upper part of young stock.

Mr. Oyler, of Cheshunt, wrote saying, " As regards Woolly Aphis, I have just planted an individual orchard of 150 acres of standard trees, which I think is the largest in England ; we have paid great attention to the selection of the trees, having grown them ourselves ; in spite thereof, we found on taking them from the nursery Woolly Aphis upon *some of the roots* ; these we rejected, and we now find very little appearance on the stems of the trees. We destroy it on the trunks by painting with carbolic soap, and find this very beneficial."

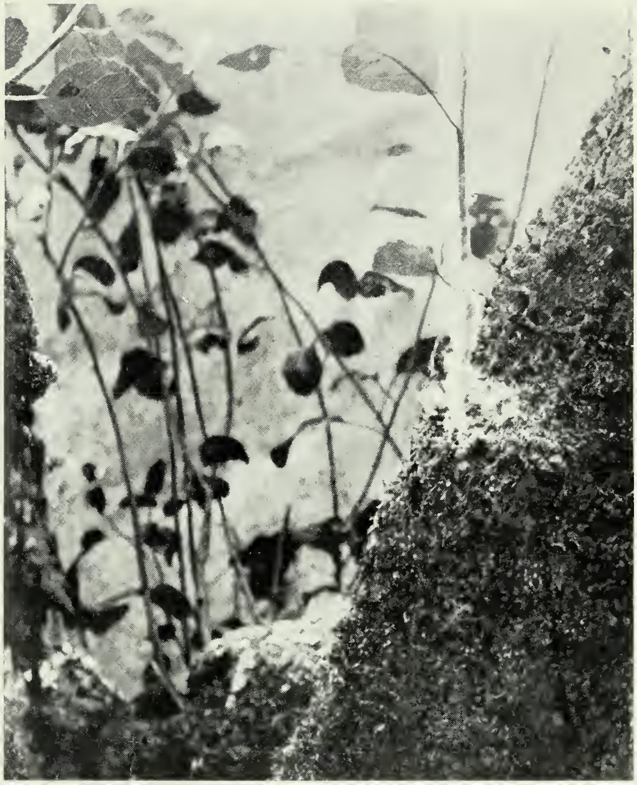
This shows the importance of having the roots of trees examined before planting.

Some stock purchased last winter for Swanley College was found to have this pest on its roots and was all fumigated with hydrocyanic acid gas before being planted. The aphis was all killed, and at the strength used the eggs also.

In the Board of Agriculture leaflet on fumigation, it states that this treatment does not kill the eggs. This is quite wrong, for it is well-known both here and in the Colonies that it does so, if used at the proper strength, such as used by the Cape Officials in fumigating imported stock.

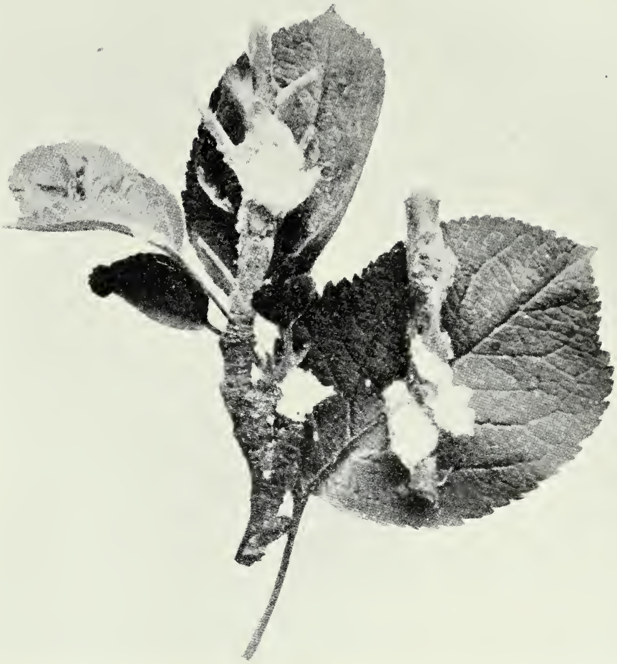
The stock at Swanley was fumigated as follows :—1 oz. sodium cyanide, 1 oz. sulphuric acid, 4 ozs. water to every 100 cubic feet of space.

The whole of the stock was treated at once in a small greenhouse and left in the fumes for forty-five minutes. All insect life was found to be destroyed. A few of the trees had their tips scorched, but this did not in the least harm them, as they were naturally all cut back after planting.



[A. V. D. Rintoul.

Fig. 24.
Woolly Aphis working up a tree from roots, present on basal twigs and suckers.



[*W. H. Hammond.*

Fig. 25.
Woolly Aphis on shoots.

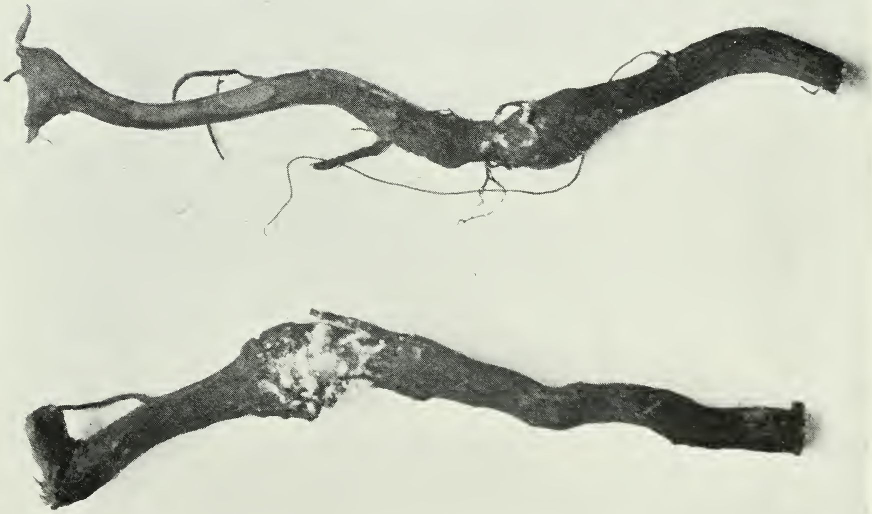


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Fig. 26.
Woolly Aphis on roots.

The Woolly Aphis was also recorded from Hernehill, Faversham, and Harbledown, Canterbury.

The Mussel Scale (*Lepidosaphes ulmi* Linn).

A large number of communications have been made concerning this pest.

The treatment found most successful is winter spraying either with Mr. Pickering's Woburn wash, or paraffin emulsion.

Writing from Ash, near Dover, a correspondent informed me that he had quite killed the scale by spraying with paraffin emulsion, and caustic soda as recommended. The strength, however, must be paid attention to, for unless a certain amount of paraffin is used, the ova beneath the scales are not affected. This probably accounts for the failure of paraffin emulsion as reported by Mr. L. Seager, of Sittingbourne, who also found lime valueless. The latter has been proved time upon time, the lime only retarding the hatching of the eggs by a few days. Nevertheless, in Canada it has been found that lime and *salt* as recommended here for Apple Sucker, effectively checks the scale.

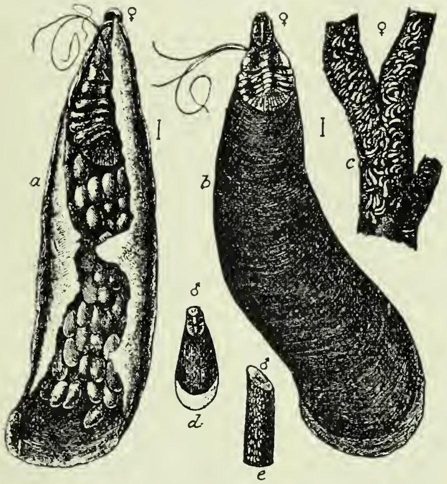


Fig. 27.—*a*, female scale, from below, showing eggs; *b*, same from above—greatly enlarged; *c*, female scales; *d*, male scale enlarged; *e*, male scales on twig —natural size.—(From U.S. Year-book, Dept. Agr.)

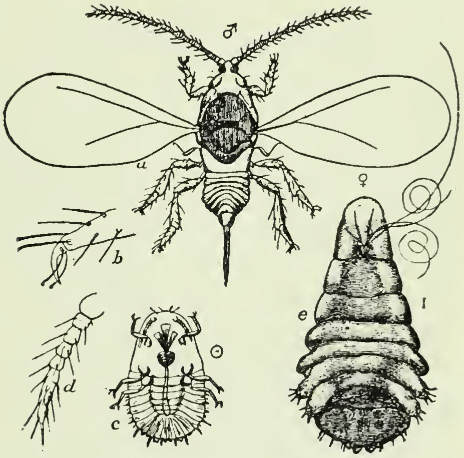


Fig. 28.—*a*, adult male; *b*, foot of same; *c*, young larva; *d*, antenna of same; *e*, adult female, taken from scale—all greatly enlarged.— (From U.S. Year-book, Dept. Arg.)

The Gooseberry Brown Scale (*Lecanium coryli* v. *sarothamni* Douglas).

A considerable amount of this Scale insect was reported in 1907-1908. From Ledbury, gooseberry shoots were sent badly infested with it, and information was sent with regard to treatment. A bad attack was also reported from Lyminge in February.

In June, Mr. Getting wrote, " We have a very severe attack on the gooseberries, large numbers of the bushes being thick with the scales, starting from near the ground, extending right up to the base of this year's growth. I am sending you one or two shoots. There appear to be two generations present ; the dark brown scales being full of eggs, the light brown covering a soft bodied insect. Three weeks ago I noticed many of the leaves covered with a shiny, slightly sticky moisture."

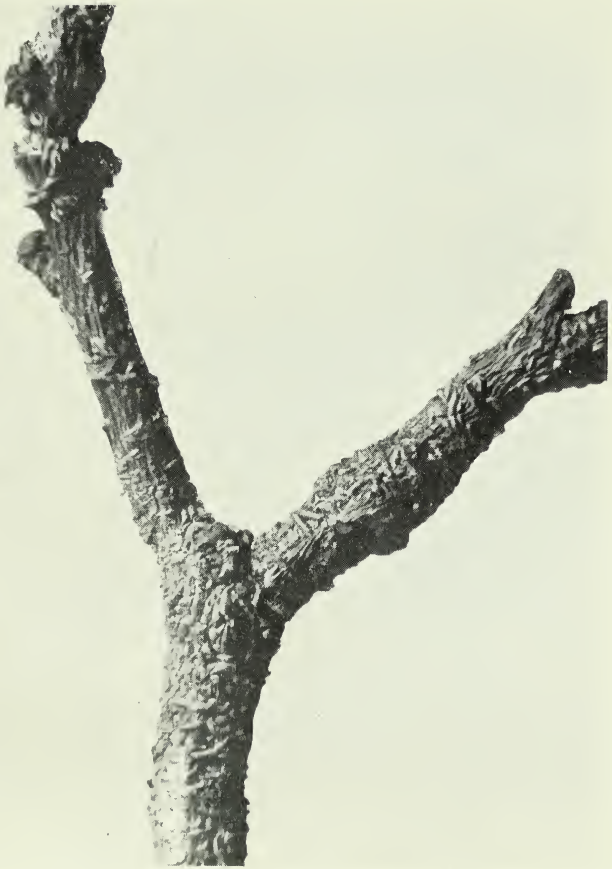
In February, Mr. Getting wrote that " After last season's severe attack, the scale was thick, and at hatching time the larvae were swarming over the bushes. The bushes were sprayed twice with very moderate strength paraffin emulsion, and it did not appear to destroy them. I could find no scale cases on last year's growth, a fair number on the previous year's, and large quantities on old wood."

Mr. Getting was advised to try spraying with the paraffin jelly that has been found so successful in killing Red Spider on gooseberries. The paraffin jelly is made as follows :—paraffin, five gallons ; soft soap, 8 lbs. ; boil both together, and when boiling add about one pint of cold water, and stir for some time.

The whole becomes a jelly when cold, and 10 lbs. of this jelly are added to forty gallons of water. The above amount makes about 160 gallons of wash (Furley).

Mr. Getting sprayed the affected gooseberries with this at half the above strength, and some at one-fourth the above strength. Shoots were sent me, and the young scales were found to be alive on both. Those sprayed with the full strength were practically all killed.

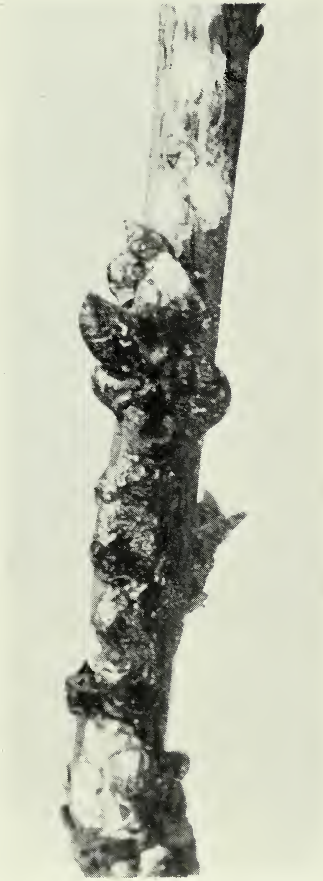
Exactly the same results were found at Wye during the past spring.



[*A. V. D. Rintoul.*

Fig. 29.

Mussel Scale on Apple Twig (*Lepidosaphes ulmi*).



[*A. V. D. Rintoul.*

Fig. 30.

Brown Currant Scale (enlarged).

The Peach Scale (*Lecanium persicae* Linn).

This scale was reported under glass at Worlingham, Surrey. Marked discolouration was to be noticed on the young wood where the scale has been, a curious dull, purplish brown staining being seen, not only on the skin, but on the underlying tissues. Spraying with paraffin emulsion had been satisfactorily carried out, and the peach trees were cleaned.

The Vine Scale (*Pulvinaria vitis* Linn).

This scale was sent me by Mr. Emptage, on Peach wood. It presented just the same appearance as when on the vine. Newstead records it under glass on both peaches and vines. In a few localities in Cheshire he says it is common on the peach, but is apparently a very local species, and does not appear to have spread much in this country. Out of doors it is found upon the hawthorn, on birch, willow, alder and *Cotoneaster* spp.

Amongst the localities he gives are Delamere Forest (birch); Lewisham (alder) ; Birdham, Chichester, Doncaster, near Maidstone, Hereford, and Stonehouse, Devon. Besides the above I have received it from vines from near St. Neots, Huntingdonshire, from near Folkestone, from Kingston-on-Thames, and from near Godalming, Surrey, on peaches. The scale is quite large, varying up to three-eights of an inch on the peach shoots sent ; in colour it varies from chestnut brown to a dull slaty grey seen in the specimen sent ; a dense white wool pad appears under it, and pushes one end of the scale away from the shoot.

Such large objects as these are best destroyed by hand, and then the places whence they have been removed painted with soft soap and water.

The Apple Sucker (*Psylla mali* Schmidb).

Of apple pests this is one of the most troublesome where it occurs. It has been known for many years, for Kollar*, quoting Schmidberger in 1837, gives an excellent account of it ; an account which some investigators who are attempting to find washes to destroy the eggs might read with advantage. Fortunately there are very many plantations free from this insect (as a pest) in Kent and Cambridgeshire, and some in Worcestershire.

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* Kollar, V. "A Treatise on Insects," p. 278 (1875.)

The Apple Sucker belongs to the family *Psyllidae*, of which Edwards* describes twenty-eight species in this country. They are related to the Frog-hoppers (*Cicadina*), but can be told at once by their two-jointed tarsi or feet. Three species occur on the apple, of which *P. mali* is by far the most abundant and frequently the only culprit. *P. simulans* Först and *P. pyricola* Först I have never yet found in injurious numbers. It has been placed by some of the older writers in the genus *Chermes*, and we find even Ormerod* calling it the "Apple Chermes." It has no connection with that group of insects.

Its attack on apples is very persistent. This fact, well known to growers who suffer from its ravages, has evidently not been noticed by writers, for we find such statements as the following: "The attack appears to be of only occasional appearance to a serious extent, and has been only specially reported to myself in 1890 and 1891, and again in 1897" (Ormerod).† Growers in Kent, Worcestershire and Surrey have reported its constant presence for many years. Mr. H. J. W. Best, of Suckley, tells me it has been a great pest in parts of Worcestershire during the past fifteen years. Mr. Ellis has had it in his plantations, near Godalming, in Surrey, for many years. Many growers in Kent have had it constantly working year after year. Certain plantations are more infested than others, of course, but there are few which I have visited in which it could not be detected. Even in the exceptionally clean plantations of Mr. W. W. Berry, of Gushmere Court, Faversham, I have found a few of the green-winged forms here and there. Few plantations are likely to be searched without a few being found—ready perhaps, to spread in great numbers. Mr. Bear tells me he has no trace now in his plantation at Hailsham, Sussex, but it used to occur there; whether it was destroyed by constant washing or died out naturally I do not know.

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* Edwards, J. "The Hemiptera-homoptera of the British Isles," p. 247. (1896).

† Ormerod, E. A., "Handbook of Insects Injurious to Orchard and Bush Fruits," p. 42. (1898).

In the plantations at Eardiston it is not nearly as bad this year (1908) as formerly, but this was due to natural causes and not any treatment.

During a tour of inspection in 1906, of the plantations in Worcestershire, very few places were found where it was not more or less harmful, and there are growers who considered that I had placed the estimated damage to the apple crop, namely 70 per cent. too low. In some parts it certainly was, for the whole blossom had been destroyed.* Mr. Dennis Best informed me that at one of his plantations at Holt Castle he had picked no apples for many years, owing to the "Sucker."

It is also harmful in Herefordshire. Mr. Getting, of Ross, writes that it is very troublesome to some of his apples. On the other hand it is not such a common insect at Putley Court, near Ledbury. The insect is common in Norfolk, Huntingdonshire, Lincolnshire, Cambridgeshire, Oxfordshire, Hertfordshire, Dorsetshire and Gloucestershire. It has been reported as doing damage at Cottenham, near Cambridge, and exists in abundance in the Wisbech district.

During a visit to many Devon plantations in 1906 and 1907, very little of this apple enemy was detected, and growers there scarcely knew what it was. The damage done by it is mainly to the blossom buds and blossoms, but leaf-buds are also attacked. This latter damage was especially noticed at Wye in 1901. The attacked leaf buds, when they open, produce only stunted and deformed leaves.† Besides being crinkled and deformed, the foliage presented a pallid appearance, often looking frosted ; sometimes these leaves died off, at others they gradually recovered. The damage to the blossom buds and blossom is much more marked and abundant. Frequently the buds never properly open, and when many of the young suckers have entered, the blossom is irreparably damaged before expanding. If only a few are present then the blossoms show well, but before the petals are ready to fall they shrivel up, and a dried brown truss remains. This is a very marked sign of Psylla attack, and it is noticed * that the dead blossom hangs on the trees a long time, often until the fruit is ripe or even the leaves are falling. Furley† records that the dead leaves showing Psylla skins remain on the trees up to Christmas, and in several orchards they were noticeable up to March. This brown appearance has given rise to an idea that the blossoms had been struck by frost. That it is Psylla work we can tell by the presence of the small insects in the trusses, and later by their dried grey skins or exuviæ which remain attached to the strigs and leaves until the end of the season. These are mostly pupal skins. It is quite easy to mistake this disease for brown rot at first sight, but in the latter the leaves die as well as the blossom, which does not occur in Psylla attack. Not all varieties are similarly affected. The Ecklinville, however, may be pointed out as suffering more than any other, possibly owing to the stalks of the blossoms being so short. The Blenheim Orange and Wellington, Lord Grosvenor, Lane's Prince Albert and Quarrenden we have seen quite ruined by this pest, but in all parts Worcester Pearmain appears to suffer least.

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* Theobald F. V. "Report on the Orchards and Fruit Plantations of Worcestershire." Worcestershire Education Committee, p. 12. (1906).

† Theobald, F. V., Report on Economic Zoology, for the year ending April 1st, 1905, p. 39. (1905).

Life-history and habits.

The adult *Psylla mali* are winged in both sexes; they occur from the middle of May till mid-November. The colour is very variable: at first they are greenish-yellow to green, the legs paler and the feet blackish. Later they change, some become brownish-yellow, others show dark markings, with even red and yellow, according to some observers, but I have never been able to find these varieties in Kent, Worcestershire or Cambridgeshire. The wings are quite transparent and have greenish or greenish-yellow veins; they fold over the body in tectiform manner when the insect is at rest. In length they vary from one-tenth to one-eighth of an inch. The venation of the wings is very characteristic and will at once separate this insect from other Leaf-hoppers with which they might be confused, owing to their jumping habits. At the least shock they skip off the foliage, and then frequently use their wings, and

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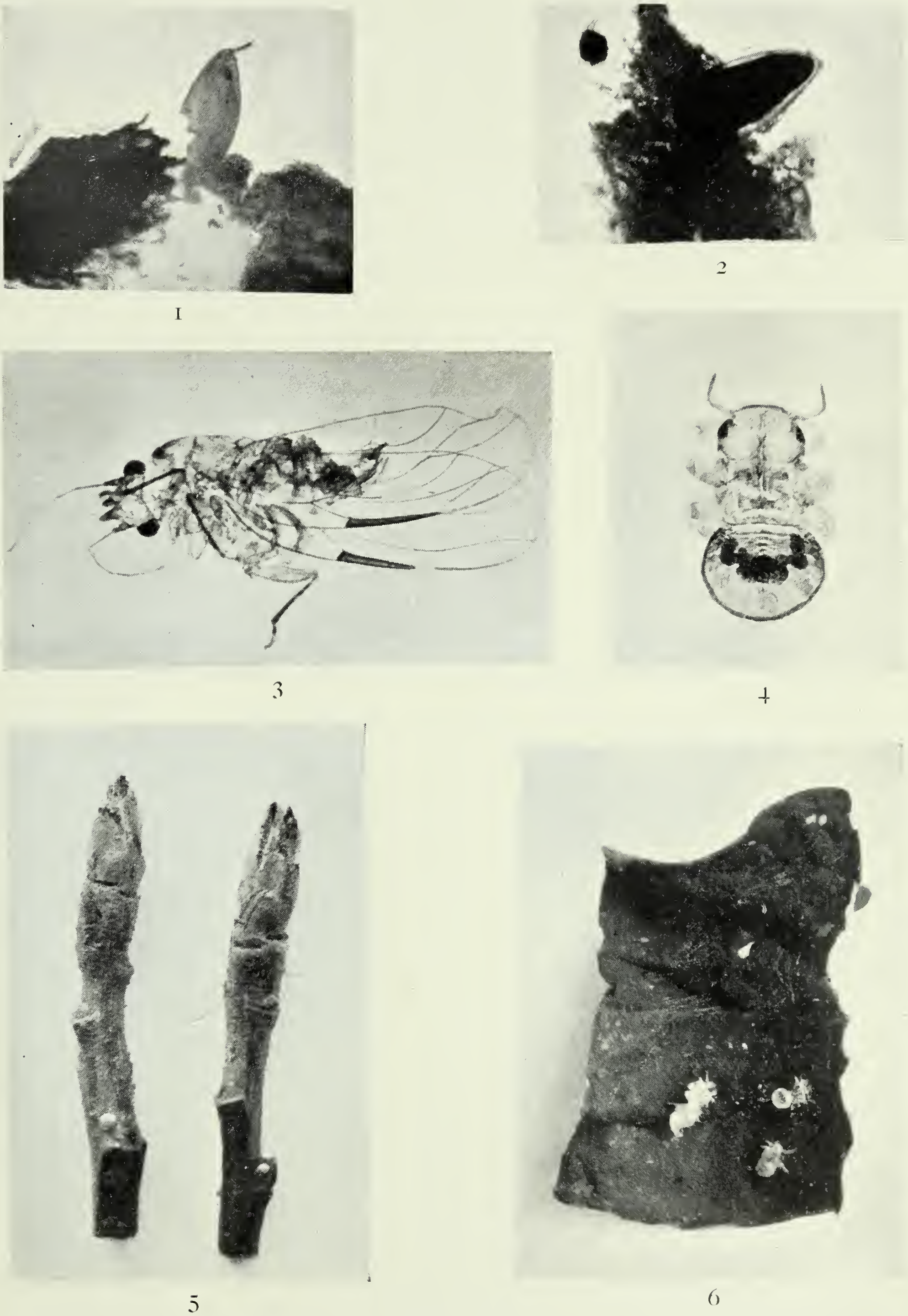
* Theobald, F. V. Report on the Orchards and Fruit Plantations of Worcestershire. (Worcester Education Committee, 1907).

† Furley, K. Report on the Experimental Spraying for the Apple Sucker. (Worcestershire Education Committee, 1907).



1—Ovum of Apple Sucker, showing whip-like process. 2—Ovum showing how it is embedded in moss. 3—Winged adult. 4—Young nymph. 5—Larvae waiting to enter buds. 6—Cast skins of nymphs.

Fig. 31.

may be seen taking short flights under and about the trees. The males, according to the observations of Furley* and myself, are usually brighter than the females, but according to Schmidberger† it is the reverse. Moreover, the latter describes their colour as being very much more varied than we usually find in England. The male he says, " in wedding attire, is either of a lively green, striped on the back with yellow, a dark yellow with broad stripes, or almost completely green with dark yellow dots ; the abdomen entirely yellow. The females are of a prettier colour and somewhat larger ; the entire back of the female, reaching as far down on the forceps at the extremity of the abdomen, is red, striped with greenish-yellow and brown, and the abdomen is orange-yellow or green ; they are green or greenish-yellow on other occasions."

The amount of variation differs in different places and in different seasons. It is the general greenish shade that the grower will notice chiefly.

These adults live on the foliage all the time, sometimes we find them at rest on the boughs and trunks. They apparently do no damage in this stage. One way in which I have never failed to find it in an orchard is to shake the trees and stand beneath, the winged forms readily collect on one's clothes. They pair towards September, and from then on into November they deposit their eggs. Before pairing Schmidberger† says five or six of them assemble on an apple leaf, and each male selects his female, and that whilst pairing is going on a tubercle appears on the last ring of the extreme part of the body, which remains there until pairing is over. The more usual plan in this country is for one male and female to be seen together. The eggs are laid in various places, but especially on the spurs, generally around the leaf ridges ; some horizontally, others in a more irregular manner ; many others are placed on the fine hairs on the year's growth and some on the buds. I have once or twice noticed a few on the smaller boughs. Many years ago Mr. Fred Smith, who first pointed out the eggs to me, noticed that they were often laid in a line end to end. I have only seen this occasionally since, and then when amongst the fine hairs.

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* Furley, K. Report on the Experimental Spraying for the Apple Sucker. (Worcester Education Committee, 1906), p. 12.

† Kollar, V. " A Treatise on Insects," p. 278 (1837).

The ova when first laid are almost white, then they become creamy-yellow, and later assume a faintly rusty hue before hatching. Furley* describes them as becoming a pale yellowish-red also. They are elongated oval in form, somewhat pointed at the ends, one of which is produced into a thin process, clearly seen in the photograph, which is apparently curled under the egg, and cannot easily be seen unless the ovum is very carefully removed. What this process is for we do not at present know.

It seems to be so closely attached to the tree that it may have some indirect connection with it, and when we remember that the eggs hatch out at different times on different varieties, which produce growth at different times, it lends some strength to the view that it acts as a thermal register.

Furley, in his careful observations, found that in Worcestershire in 1906, very few eggs were laid until the middle of October. In Kent we have found many as early as September 24th. Laying certainly may go on until November in late years.

Mr. Getting records* that, at Ross, he found plenty of eggs on the 14th of September, and at Pershore they were observed some days earlier.

With fresh eggs we may also find numbers of empty egg shells ; sometimes I have counted twenty empty shells to one sound one. These are mainly old shells of the previous broods, but some few may have been destroyed by predaceous mites ; for, in some twigs sent me by Messrs. Caleb Lee and Sons, of Swanley, a small red acarus was watched destroying them.

The presence of these old egg shells is very important. They partly explain the frequent errors that have been made in regard to washes having destroyed the ova.

On certain twigs one will frequently find that none of the eggs that even look sound, hatch out, on others a few only do not incubate. Those that do not hatch are normal infertile eggs and also are included with the old eggs supposed to have been killed by various corrosive washes.

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* Furley, K. Report on the Experimental Spraying for the Apple Sucker. (Worcester Education Committee, 1906), p. 12.

* Theobald, F. V., Report on Economic Zoology, for the year ending April 1st, 1906, p. 51. (1906).

Another point of great interest concerning the eggs is the irregularity with which they hatch out. The date not only varies in different localities and in different years, but during the same season in the same plantation. They incubate at different times on the different varieties of apples upon which they are situated.

This may be due to the heat generated by the flow of sap regulating their hatching to the time of the bursting of the buds.

In 1906, they hatched out at Wye on the 10th of April on one tree under observation; not until 27th, on another close to it.

As much as seven days difference was noticed at one place by Mr. Furley (at Pinvin); those on the Blenheim Oranges hatched on the 3rd of April, those on the Wellingtons not until the 10th of April, and it was particularly noticed that they hatched first on the Ecklinville, one of the earliest of apples. Not many miles away, at Eardiston, they did not commence to appear until the 12th. In Kent they have been found to vary in incubation between March 24th and April 27th.

Schmidberger records them as hatching in Germany on April 5th, simultaneously with the bursting of the leaves.

The small larvae coming from the ova at once ascend to the buds, and if they are not sufficiently open they may be seen seated on the buds waiting to gain entrance. (Fig. 31, 5.) First they are yellow to dirty-yellow with brown markings, bright red eyes, brown feet and about the size of a pin point; their curious form is seen in the photograph. They are quite flat and soon work their way into the folds of the buds and at once commence to feed. Sometimes these little larvae are quite green, at others quite dark in colour.

Schmidberger found that the larvae cast their skin on the second day after birth, and soon after this that characteristic globule seen in the buds and open trusses makes its appearance from the larval body, and then the white thread appears by which the oily globule is attached. Another moult takes place in a few days and then the larva not only is provided with the thread and globule but also a number of white waxy threads which partly cover its body.

This second change I have found may take place ten days after hatching. Until recently the first moult observed by Schmidberger was not seen.

After changing the second skin, the Psylla becomes green all over and the abdomen larger and broader than the thorax, and small rudiments of wing-buds appear. This is the first nymph or pupal stage. Like the larva it has a long thread and waxy globule, and becomes still further covered with white waxy threads and fine, curled, hairlike particles.

The third change of skin takes place in from eight to ten days and the wing rudiments become more pronounced. After this moult the filament and fine curly threads are mostly pale blue.

The nymphal stages I have usually found on the leaves ; the fine filaments seem to hold two leaves together and thus shelter the Suckers. Often several nymphs are found close together between the two leaves.

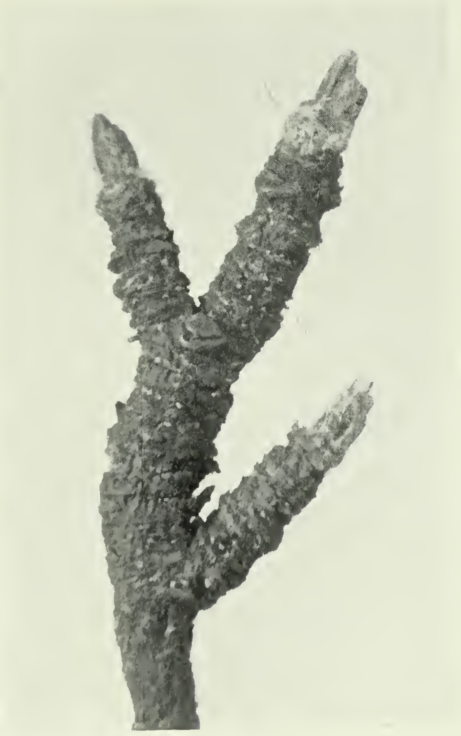
Previous to the final moult, the nymph fixes its beak firmly into the leaf and then the skin splits and the winged adult emerges and leaves its cast skin firmly attached to the leaf. (Fig. 31, 6.).

The whole cycle from the hatching of the egg to the bursting forth of the adult takes about four weeks. The colour of the pupa varies, those found between the leaves are yellower than those free on the foliage. The antennae are very marked, being darker at the tips, which are bifurcated, the same as in the winged adults.

As far as we at present know, the apple is the sole food plant of this Psylla. One year I found numbers of it on a hawthorn hedge near some apple trees in my garden, together with the *Psylla crataegi*, but they do not breed on hawthorn, and had evidently only gone there for temporary shelter. They may also be found in the winged state on pear and plum and currants, where mixed with apple, but they are there only as casual visitors, and not for depositing their eggs. As soon as the male has fertilised the female he dies, but the female lives some days after.

Prevention and Treatment.

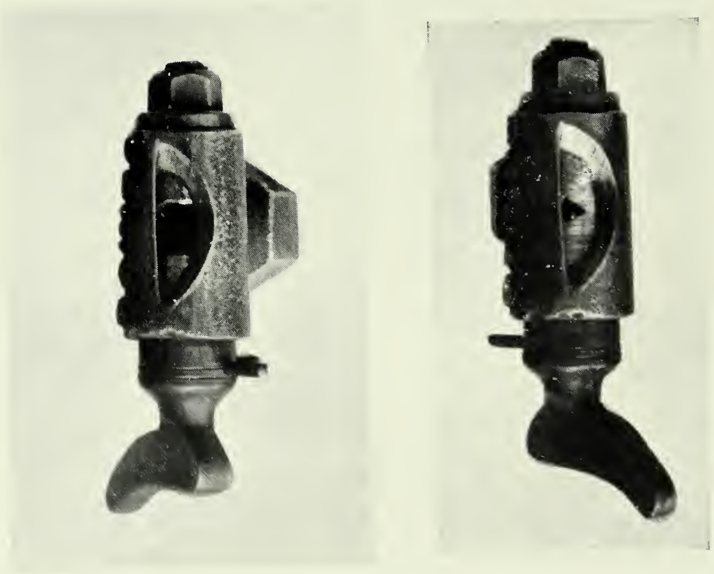
The prevention of Apple Sucker damage is no easy matter, owing to their hatching out irregularly. Spraying to kill the young is very unsatisfactory unless we have only one variety of apple in



[*A. V. D. Rintoul.*

Fig. 32.

Ova of Apple Sucker.



" Seneca " nozzle :—Open so as to blow out solids.

" Seneca " nozzle :—Set for spraying.

Fig. 33.

a plantation. Under such circumstances, we may destroy very large numbers by spraying with soft soap and quassia if we do so when we find them as shown in figure 31, 5, namely, waiting outside the buds. Even then not all will be destroyed, as even on the same tree they do not all hatch in one day.

Spraying when the Suckers are inside the trusses is remedial and referred to later.

The various statements made that certain washes will kill, corrode away, etc., the eggs, must be taken with caution. None tried have any appreciable effect in this direction; and the careful experiments carried out by Mr. Furley in conjunction with many Worcestershire growers show clearly that no washes have any material effect in killing the eggs by corrosion. Mr. H. Holder, of Stamford Bridge, Worcester, wrote saying he had used paraffin emulsion and caustic soda last season, and found it of very little use against the Apple Sucker, Nor when we remember the structure of the Psylla ovum can we consider this likely to take place, unless the wash is so caustic that the trees would be killed. The various statements made as to mortality in the eggs after spraying have been, of course, given in good faith, but the gentlemen who recommend these ovicides have not taken into account two factors. First, as pointed out by Schmidberger in 1837, that the ova will not hatch on shoots cut off the trees unless they have been cut off a few days only prior to normal hatching. In one batch of shoots sent me by Mr. Furley from sprayed trees, some twelve Psyllae hatched out of some hundreds of eggs, one might have said the various washes had killed all the rest. Unfortunately, untreated twigs were sent and fewer hatched out as it happened from these than from those which had been sprayed, the reason being that the eggs mostly lose their vitality when the life of the twig is destroyed. Secondly, experimenters may neglect the fact, in their "egg-counts," that many old egg shells remain, and these are what they have probably assumed the wash has destroyed.

Messrs. Cooper and Nephews brought out a patent wash called V. i., said to destroy these eggs; like others it had no effect in the orchards and none in the laboratory as far as I could see. The wonderful pyrotechnics of squirting protoplasm when the wash was put on the eggs with a camel hair brush, also failed to appear.

The only treatment found of any use in preventing the young from entering the buds is spraying the trees with the thick lime and salt mixture. Mr. Howard Chapman first called my attention to this and was so confident of the good done in his plantations that further experiments were conducted at Wye College, and these bore out what Mr. Chapman had found ; check trees in both cases being kept. Still more definite results were obtained by Mr. J. H. W. Best, of Suckley, Mr. Montague Taylor, of Shelsley Walsh, and Mr. Martin, of the Toddington Fruit Grounds. Crops of apples were obtained by the former for the first time for many years on the treated trees, while the rest of the plantations suffered as usual. Where failures have taken place such as recorded by Mr. Walter Collinge, and notified to me by Mr. Caleb Lee, of Swanley, the cause has probably been because the wash was not put on thick enough. During the past spring Messrs. Caleb Lee, however, found this the best treatment of many they tried. The wash does not do any such impossible thing as corrode the egg shells, it acts as a mechanical barrier to the escape of a very large number of the young, and at present is the only treatment which gives the least relief in this serious attack.

Spraying with soft soap and quassia or paraffin emulsion, when the Suckers are in the trusses of blossom will do a little good if the blossoms are hit fairly hard so as to drive the liquid in. Messrs. Oyler, of Fairley Farm, Cheshunt, write as follows : " When we notice what always appears with the first blossom, viz., the oil globules, we spray with soft soap and quassia, and have found this very beneficial."

The paraffin wash found successful by two large Worcestershire growers is made as follows :—Soft soap 8 lbs., paraffin 4 gallons, water 100 gallons.* But I have noticed that where this wash is used and the spray trickles down into the trusses that scorching often results, and as Mr. Murdock, of Linton, pointed out last year, does as much harm as the suckers. But, at the rate of 2 gallons of paraffin, 4 lbs of soap to the 100 gallons of water, Mr. F. Smith, of Loddington, tells me kills the Psylla and does no harm.

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* Theobald F. V., Report on Economic Zoology for the Year ending April 1st, 1906, p. 37 (1906).

Tobacco wash is by far the best for this purpose, and kills a much greater percentage of the insects, seeming to have high penetrative powers. The mixture experimented with was made according to Mr. Spencer Pickering's formula, by Voss and Co. Its cost, however, is, at present, too great to it use on a large scale (12s. 6d. for 100 gallons).

Some few years ago attention was drawn* to autumnal spraying with paraffin emulsion to kill the winged adults before they lay their eggs. The time to do this is soon after the fruit is picked and the emulsion may then be used at double its normal strength. The emulsion must be sent out in a dense spray and directed not only over the leaves, but also at the clouds of Suckers that fly under the trees. Mr. Smith, of Loddington, wrote me in 1905, that he thought very few would be hit, but from personal observations it has been found that the majority can be easily killed. Mr. Ellis, of Bramley, tried this treatment in badly infested plantations in the autumn of 1906, and the result was that the Psylla were practically exterminated as they were in my own garden two years previously, and we venture to think now it has been found successful by a large grower that others will try it. It is possible also that the Ingestre trees and Lane's Prince Albert at Messrs. Caleb Lee's were cleared by late *summer* spraying (for aphis) with paraffin-naphthalene emulsion, for they were badly infested last year ; but there were no eggs to be found in the winter. It seems that with it and the lime salt wash the damage done by this serious pest may be practically reduced to *nil.* Where this has not been done the use of tobacco wash may safely be recommended.

Natural Enemies.

So far no insect parasites have been recorded from this pest. A small red acarus was observed once feeding on the eggs, but has not been noticed since.

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* Theobald, F. V., Report on Economic Zoology for the year ending April 1st, 1905, p. 39, (1905.)

Schmidberger* mentions two mites, one deep red, the other a dirty yellow, which pursued and sucked the young of this insect and cleared them off a pot tree under observation. He also found the light-green pupae of one of the garden bugs pursuing the young Suckers and piercing them with their beaks.

The Blue Tit and the Long-tailed Tit take a certain number of ova, and I have known shoots quite cleared of the eggs by a family of the latter bird. No enemies are known, however, which do any appreciable good.

Schmidberger* describes the adults as "subject to a kind of disease which appears to deprive them of the power of eating; as in this case the leaves on which they are found are not in the slightest degree injured. When thus affected the head and thorax of the insect are snow white and their abdomens are ringed with black." This fungus was probably *Entomophthora sphaerosperma* of Fresenius† which is common on the Leaf-hoppers (*Typhlocyba* spp). This fungoid parasite is white at times, at others pea green.

The Lime and Salt Treatment.

Since attention was drawn to this in 1906, a number of experiments on a large scale have been carried out, some by Mr. Furley, under the Worcestershire County Council, some at the College, and a very large number by fruit-growers in Kent, Worcestershire, etc.

The method of killing scale insects with lime and salt is a very old one, and has been found successful in Canada in recent years for the same purpose. In Nova Scotia it has also been experimented with as a means of preventing Apple Aphis.

In regards to the latter, observations were made in 1907, but no abnormal hatching resulted, about 40 per cent. of the eggs incubated, which was found about the average for some three dozen lots kept as checks.

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* Kollar, V. "A Treatise on Insects." p. 278 (1837).

† Cook M. C. Vegetable Wasps and Plant Worms, p. 304 (1892).

Nevertheless the apple trees sprayed with this wash in 1907 and 1908 this year show no signs of leaf curling aphis, whilst the check trees have this pest on them, but not to a serious extent.

In Mr. Howard Chapman's plantations at Greenhithe, the same absence of Apple Aphis is observed this year where the lime and salt has been used. It seems therefore that further experiments in this direction may prove useful.

In pointing out the benefit derived from lime and salt spray for Apple Sucker in 1906, Mr. Chapman also said it seemed to appreciably affect the attack of Plum Aphis ; consequently I tried this on my plum trees which have been attacked by this insect for twelve years consecutively, and scarcely an aphis hatched from the many eggs seen in the axils of the buds. This season, after a second dressing, scarcely a trace could be found on the washed trees, whilst the ones close at hand were so badly attacked that quite half the foliage commenced to curl. These trees were then washed with tobacco wash, and the aphis practically exterminated. At Messrs. Caleb Lee's at Swanley, the same result was noticed, according to the "*Fruit-growers*" paper, where it is reported as follows :—"*Czar Plums.* Sprayed at same time and same fluid ; quite uninjured. Remarkable." (April 6th. Lime and salt, 50-lbs.).

Some trees were also sprayed on the College plantation by Mr. Deadman with similar results.

Other cases may be quoted, but sufficient has been said to show that for this aphis the wash seems to be of considerable value.

The reason is quite evident, the lime forms a barrier where it collects, and remains a long time in the axils of the buds thus preventing the egress of the delicate young aphis from the ovum. There may be another action due to the osmotic power of the salt, but no detailed experiments have been made in this respect. It may be pointed out, however, that on one plum tree sprayed only with lime, the result was certainly not as good as on those sprayed with the lime and salt.

The experiments in connection with Apple Sucker have been wider, and have been carried out conjointly, in Worcester by Mr. Furley, and myself, with the help of many growers, in Kent. The general results show now very conclusively that this so far is the only treatment of any practical value for preventing the Psylla from entering the buds, and we must remember the period of worst damage is when they are working in the just opening bud, when tobacco wash, etc., can scarcely be expected to be effectual.

The first experiments in connection with the destruction of Apple Sucker were carried out with great care by Mr. Howard Chapman. Thirty-five acres of apples were sprayed that had not produced a crop for fourteen years, and in that year a heavy crop was gathered ; whilst two rows of untreated trees were ruined in the same orchard.

In 1907, some plots were treated on the College plantation with the same formula used by Mr. Chapman, and variations as recorded later. Although there was not much Psylla, enough was present on a row of Ecklinvilles running through the plots to serve the purpose. Although by no means was the pest stamped out, yet there was a very marked decrease on the treated plots. It may be pointed out here that the wash was not put on in anything like the proper thickness. According to the horticulturist, Mr. Deadman, the knapsack sprayers not having sufficient power to drive a thicker wash.

At the same time trees were also treated at Wye Court with a wash of the proper consistency put on with an " Abol " sprayer, purely as an experiment. The trees treated, Worcester Pearmain, Suffield, and two old orchard trees where Sucker was rampant, were practically cleared, only an insect here and there remaining. In his Report*, Mr. Furley says, " Lime and Salt undoubtedly has proved the most efficacious of all those used, but at present it is by no means perfect, though the attacks at Suckley (especially), Shelsley Walsh and Toddington, have been greatly reduced, this proving to be the only wash of any value for this particular pest."

As a preventive of Apple Sucker, the experiments continued by the Worcestershire County Council were confined this last season mainly to this treatment, the full details of which will appear in Mr. Furley's Second Report. When visiting Worcestershire in May last, there was no doubt that it had worked even more beneficially than in the previous year. No more conclusive proof of its practical value could be given than the great cost, trouble and energy that Mr. J. H. W. Best, of Suckley, has put into this, treating practically all his large plantations.

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* Page 20.

Mr. Emptage, who made a close examination of Mr. Chapman's plantations this year, reports to me that little winged Psylla is present; this shows that still further reduction has been made since last year.

The results have been still more conclusive on the College plantation, the plots sprayed with the lime and salt showing scarcely a Psylla this year, whilst some were to be found on all the unsprayed plots, and that sprayed with V.i.

Messrs. Caleb Lee reported in 1907, that their Grosvenor Apples, which were bad with Psylla, were sprayed on March 18th, 1907, with lime and salt, but showed no improvement; on the other hand apples on grass at their home farm, which were equally bad in 1906, were very much cleaner. Such discrepancies are explained by weather conditions.

Mr. Montague Taylor, of Shelsley Walsh, Worcester, wrote in June, 1907, saying, "The lime and salt washing answered very well; the trees seem free from Psylla and the fruit has set well."

In 1908 Messrs. Caleb Lee used this wash again amongst others, using as much as 50 lbs. of salt, spraying on April 6th some Ecklinvilles, the Psylla was practically cleared, but some damage was done to the buds. Some Newton Wonders were washed April 11th, and the Psylla cleared and no harm done to the buds, this wash also contained 1 lb. copper sulphate. Ecklinvilles, Lane's Prince Albert and Cox's Orange Pippin had the buds damaged to some extent. It thus seems that some varieties have their buds damaged (besides those mentioned also Grenadier), when sprayed late with as much as 50 lbs. of salt to the 100 gallons. No ill effects have been noticed, as far as I know, with 30 lbs. of salt to the 100 gallons of lime wash.

There is some idea that salt is not necessary, but from experiments made it seems that the salt is essential, for a greater percentage of insects are killed when it is added to the lime.

That the lime acts mechanically there is not the least doubt, for one can watch red spider hatching on treated trees, and many of them never move far through the particles of lime which stick to them, and die, and in the case of Plum Aphis this certainly is the rule. With Psylla the lime forms a layer over those eggs, and they are many, which are placed along the leaf scars and in crevices; these could never hatch. It seems also, however, that the salt has some osmotic action, for when this is used one notices that those eggs which the spray goes thickly on change colour, to a marked leaden or almost dull plum hue from their normal yellow tint. These ova never incubate.

The time of spraying with lime and salt appears best as near as we can get to the hatching of the eggs, and should be completed before any have commenced to hatch. The spraying should stop as soon as the bud scales commence to open, for after, it appears some damage may be done to the buds, from Messrs. Caleb Lee's report. Mr. Martin, of Toddington, also wrote and sent some shoots on which the buds were slightly harmed, but he afterwards informed me that they grew away quite sound. This damage is unusual and never serious.

The time to commence the washing must depend on the acreage to be treated. Excellent results have followed spraying at the end of February and beginning of March, but the best when it has been done in the latter part of March, and during the first few days in April.

Formula of Wash Recommended.

Lime 1½ cwt.
Salt 40 lbs.
Water 100 gallons.

The lime should be the best white lime fresh from the kiln. "Flare" lime where obtainable is the most satisfactory, as it contains no grit.

Experiments made with rock lime, however, have proved just as successful, but the grittiness is bad for the machines.

The lime wants slaking in the water and straining off through sacking or fine sieves into another vessel, and then the salt added and well mixed, but I have found it best to dissolve the salt in the water first.

The wash is then ready to use.

The addition of waterglass, alum and other substances to make the lime adhere more firmly to the bark does not seem to repay the extra cost, as it adheres but little longer with any of the ingredients so far used. Waterglass at the rate of 5 lbs. to the 100 gallons has proved the most successful in checking the flaking off of the lime as far as the experiments conducted at Wye show, but in one of Mr. Spencer Pickering's experiments it proved of no value, whilst in another it did. As it does not seem essential it may therefore be discarded.

Experiments at Wye, 1907.

To find a cheap sticking medium, the following were the washes tried :—

(1) Plain chalk lime and salt as used by Mr. Chapman.
(2) Whitening and salt.
(3) Lime, paraffin and salt.
(4) Lime, waterglass and salt.
(5) Whitening, paraffin, and salt.
(6) Whitening, waterglass and salt.
(7) Lime, treacle and salt.

The amounts of lime and whitening used in the above was 1 cwt. to 40 gallons of water and 10 lbs. of salt.

The waterglass at the rate of 2½ and 5 lbs. to the 40 gallons.

Numbers 2 and 7 were soon discarded, the rains at once destroyed 2 and the effect of 7 was very poor. Numbers 3 and 4 withstood the weather best, and after heavy rains the trees were still coated with lime sufficient to stop most of the eggs from hatching.

A second series of experiments were conducted with fine powdered limes that had been ground some time, and results were very poor, they did not clean up the trees as well as the fresh lime. But where fresh rock lime was used the effect was much the same as with chalk lime.

The results of the above experiments were to show that waterglass and paraffin acted best as media for holding on the lime and preventing flaking, but the difference between them and the plain lime and salt was not great.

Experiments in 1908.

These were to (i) further check the use of waterglass and paraffin, and (ii) to find the quantity of salt the buds would stand.

Plots were sprayed on the College Farm, and individual trees elsewhere.

Plot A, six rows, sprayed with V.i. (Cooper and Nephews). March 14th.

Plot B, six rows, check,

Plot C, six rows, lime 40 lbs., salt 12½ lbs., waterglass 2 lbs., water 40 gallons.

Plot D, six rows, lime 80 lbs., salt 12½ lbs., water 40 gallons.

Plot E, six rows, lime and salt and paraffin (3 gallons to 100).

Plot F, six rows, lime 40 lbs., water 40 gallons, sprayed twice.

Results.—No difference seen in Plot A, Suckers, Winter Moth and Tortrix larvae hatched as usual. Plots C, D and E had very few Apple Suckers hatch out, most of the ova not incubating. On all these plots Winter Moth hatched out as usual. C and E were practically cleared of apple suckers, some remained on a few trees in D, but on the remainder of the plantation there was a quantity of this insect. Plot F showed very little difference as regards health of the trees, but more suckers hatched out than on C, D and E.

The waterglass and paraffin made such a slight difference that we may in future discard them as far as results showed here.

Second Series of Experiments.

Some old and young trees were sprayed to see effects of the salt on buds.

Trees A, lime 1½ cwt., salt 30 lbs., water 100 gallons (March 26th). No harm.

Trees B, lime 1½ cwt., salt 40 lbs., water 100 gallons (March 27th). No harm.

Trees C, lime 1½ cwt., salt 50 lbs., water 100 gallons (March 27th). No harm.

Trees D, same as C, but sprayed April 7th, some buds damaged.

All these old trees presented a clean appearance, moss and lichens disappearing, Psylla very much decreased.

A single young tree was sprayed with the lime and salt with starch, but the effect of the starch was only to make the lime flake off more than usual.

Some difficulty has been experienced with this wash, owing to its blocking the nozzles. This is overcome by using the "Seneca" nozzle, and we also learn that Drake and Fletcher's nozzle is equally good.

Summary.

Lime and salt wash prevents the hatching of large numbers of the Apple Suckers, its effect varying according to the thickness put on the trees, the thoroughness of the application, and as to whether it has dried on well before rain comes.

No ingredient yet known prevents *to any great extent* the flaking off of the lime on smooth wood. Waterglass or paraffin to some extent cause it to hold slightly better.

Up to 40 lbs. of salt may be used to the 100 gallons without injury to the buds, over that may damage the buds of some varieties.

As much lime as possible should be used to make a thick coat.

This treatment also lessens the Plum, Hop and Damson Aphis and to some extent Woolly Aphis, but has, as far as we know, no effect on any other insect eggs, and is recommended only for Psylla and Plum Aphides.

Beetle Mites (*Oribatidae*).

Although general observations have shown that the Beetle Mites are innocuous to fruit and forest trees, yet two cases have been reported where damage is said to have been done by them. One was from Swingfield ; Mr. Birch, of Stockham Farm, wrote in June, that they were doing damage at the base of the bloom, and to the lateral buds.

Another case was reported where they were said to be damaging currant bushes near Tenterden. Neither of these cases were investigated.

Mr. Harnett also wrote from Newington, Sittingbourne, on May 9th, that he was finding numbers of the mites under apple bark, and that he *thought* they were injurious.

Great numbers of *Oribata lapidaria* were received on branches of Early Victoria Plums, from Mr. F. Glenny, of Walsoken, Wisbech, in March, but nothing was said as to any damage attributable to them.

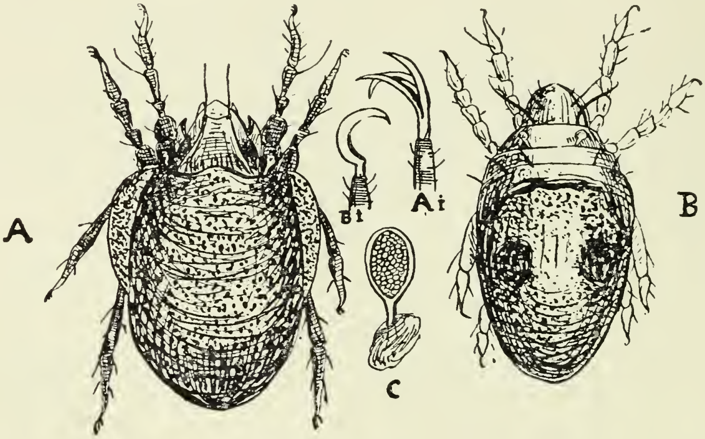

Fig. 34.
Beetle Mites (*Oribatidae*).
A. Adult *Oribata lapidaria* ; B. Nymph ; C. Stigmatic organ.
Ai. and Bi., Ungues.

Considerable numbers were found in Mr. W. Berry's plantations on cherry trees, the shoots of which were dying, but there seemed no connections between the death of the shoots and the mites.

The Nut Gall Mite (*Eriophyes avellanae* Nal).

Varied opinions exist as to the harm done by the Nut Gall-Mite (*Eriophyes avellanae*). Some growers say it is increasing and doing harm, others that it does little damage. It attacks mainly leaf buds and thus is not likely to do so much harm as the Big Bud Mite of the black currant, but nevertheless it must do some damage when present in large numbers.

A correspondent writing from Biddenden stated that his young cob-nuts had a great many swollen buds, and wanted to know if they would grow out of the disease.

As old trees do not seem as liable to it as young, it is quite possible they may do so.

There is no connection between this species and the *E. ribis* of the currant, nor are we aware that any authentic record exists of an interchange. It would be well to have all big buds picked off as soon as they show, as there is always a possibility of their increasing to such an extent as to cause harm.

The " Going Wild " of Black and Red Currants.

During the last eight years there has been noticed in black currants a curious appearance of the leaves on bushes in many of our plantations. The foliage becomes quite altered in general appearance, the leaves assuming a more pointed and serrate form. Concomitant with this is noticed a gradual decrease in the bearing power of the bushes, and in some cases that have come under personal observation total barrenness.

In some parts of Kent, these diseased bushes are known as " bucks," and are wisely grubbed and burnt.

This curious leaf formation has also been noticed by the Rev. Francis Chambers, of Lested Lodge, Chart Sutton, Maidstone, on red currants. Concerning this disease, he wrote as follows :— " I find what appears to me to be a new disease in Red Currants which I cannot account for, certain boughs go ' nettle-headed ' as we say, that is, the leaves take the appearance of stinging-nettle leaves, just as those in the black currant do, which are invaded with the ' big-bud ' or *Phytoptus ribis*. I observed it for the first time last year, and thought it was owing to a bad ' kind ' or ' skewed sort,' as we say, having got in amongst the plants. But this cannot be so, because some boughs on the same plant are sound and bear good crops, and others I have look just as if they had been frozen. It appears to spread. The disease seems to me to be dangerous."

Mr. Martin, of the Toddington Fruit Plantations, complains of this disease, and attributes it to the after effects of *Eriophyes ribis*. It is also spreading on Mr. J. H. W. Best's plantations, at Suckley.

When visiting Mr. W. Berry's farms, numbers were noticed in this condition, and I was told that it was increasing.

Mr. Paget Norbury, of Malvern, also mentioned it to me during a recent visit there.

In my own garden every bush of the old cottage garden kind of black currant, that resisted Big Bud until four years ago, when they were badly attacked, developed this curious appearance, and became almost barren. Those bushes which had escaped the *Eriophyes* did not " go wild."

The appearance of the leaves pointed to some such attack as eelworm, but I have failed to find any trace of these nematodes and no signs of any insect or mite attack.

From the observations made, and the information collected one feels disposed to assume that it is the after effects, the sequelæ of an attack of the *Eriophyes ribis*. Mr. Wm. Berry looks upon this as being the cause, just as Mr. Martin does. At the same time one or two growers tell me it appears where Big Bud has not been noticed. That it occurs *chiefly* where Big Bud has been, points, however, to that as being *one* of the causes of this degeneration, if not entirely so.

Further observations and collection of evidence is necessary before one can hope to settle what is the actual cause of this serious disease, which is worse than Big Bud, and which undoubtedly is spreading very rapidly in some plantations.

The Pear Leaf Blister Mite (*Eriophyes pyri* Nalepa).

This gall mite is common in many European countries, and has been spread by means of nursery stock to Canada and the United States of America, the Cape and Australia.

The disease affects the pear and apple, and unfortunately has been very much on the increase in recent years in this country.

Ten years ago, although well known * it was not considered very harmful as it spread so slowly. During the last two years it has taken to spread with great virulence.

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* Theobald, F. V. *Journal of the S. E. Agricultural College*, No. 7, p. 6. (1890).

It has been reported from very many places in Kent and Surrey, and I have also seen it at work in Devon and Worcestershire.

During the past year a bad attack was reported from Godalming, another from Selling, and again from Pett Place, Charing.

It has only once been sent me on the apple in this country, but in America it is quite common on that fruit.*

The disease has become more serious recently because it has attacked the fruitlets as well as the leaves.† Mr. Ivo Neame reported this form of damage in May last year, with the following note : "The enclosed is a new visitation, viz., red blotches on the pears. These are off the Pitmaston Duchess. In appears only in those which are running, but by no means in all of them ; not at all on the set fruit. Just when the leaves came out a few red spots appeared." The disease manifests itself as small blister-like patches on the young leaves. At first the little pustules are red, then green or pallid yellow, later on as the leaves get older they become black. These "galls" vary from mere specks up to a quarter of an inch in length. Many may often unite and then the leaves fall off. The effect may be noticed as soon as the leaves begin to unfold, and it is in this early period that much damage is done.

On the fruitlets small reddish pustules appear as soon as the blossom has fallen or even when still out. Attacked fruitlets were noticed to be entirely destroyed, but sometimes they appear to partially recover and then stunted fruit results. On cutting a section of the galled leaf the mites, very few in number, will be found in the mesophyll tissues.

It has been noticed that when trees have their leaves attacked, the fruit is small and gritty.‡ I do not know if this is invariably the case, although several correspondents have pointed it out.

All varieties of pears are attacked ; notes have been sent me of its presence on over a dozen kinds in harmful numbers.

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* Parrott, P. J., Hodgkiss, H. E., and Schoene, W. J., The Apple and Pear Mites. Bull. No. 283. New York Agricultural Experiment Station. (Dec. 1906).

† Theobald, F. V. Report on Economic Zoology for the year ending April 1st, 1906, p. 51. (1906).

‡ Theobald F. V. *Journal of the S. E. Agricultural College*, No 7, p. 6 (1890).

Nalepa* also records it from the Service-berry (*Amelanchier vulgaris* Mönch), the Cotoneaster (*Cotoneaster vulgaris* Lind.), the White Bean tree (*Sorbus aria.* Crantz), the Mountain Ash (*S. aucuparia* L.) and the Wild Service tree (*S. torminalis* Crantz).

Life-history and Habits.

The small mites winter under the bud scales, and as soon as the leaves open, they enter them through the stomata. They winter preferably under the second and third layers of bud scales, often in colonies of as many as fifty. In spring they are seen first in numbers towards the base of the growing bud scales, and here they seem to moult. At first they produce a small red pustule, no bigger than a pin point, by the end of a week it may reach the size of a pin's head. Each gall contains but a single female, and she deposits a few eggs, from five to six as far as observed, and these during an interval of several days. As the leaves unfold, the mites, which breed in the galls, crawl out and enter fresh stomata on the same or other leaves, and so the disease spreads. They keep on migrating through June, July and August, and even into September. As the galls grow older, they change in colour, eventually getting to black spots of dead tissue.

As the leaves mature off, the mites migrate to the forming buds and these they enter between the outer scales. The terminal buds seem to harbour the most.

In May and June, if there has been very rapid increase, the mites may be found upon the pubescence of the young wood and on the leaf petioles. In autumn they leave the foliage, and may be found moving on the trees and entering the buds.

The mite is very like the Big Bud Mite of the Currant.

In America the late Professor Lintner found that "Under ordinary circumstances it spreads rapidly and proves quite injurious if allowed to continue through the season and for successive years."

Lounsbury† considers it a recent importation into the Cape, for only young and newly grafted trees have become infested.

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* Nalepa, R. Zur Systematik du Gallmitten, p. 50.

† Lounsbury C. Report of the Government Entomologist for the year 1896. Cape of Good Hope. (Dept. Agri.) p. 126. (1897).

The effect of weather on this mite seems important in Canada.* Mr. Dickson, of Guelph Agricultural College, has informed me that while artificial means of checking this pest have failed, the extreme severity of winter in Canada had checked their numbers.

The eggs are found lying in the soft tissue of the leaves ; they are oval in form, bluntly rounded at each end, whitish and translucent. They take a week to hatch. We have never found them except in the leaves, but Parrott† has found them in America at the base of the bud scales and in the pubescence of the buds.

The adult varies in colour from clear white to translucent white, and now and then with a pinkish tinge. The cylindrical body is annulated. The abdomen has about eighty rings. The size varies very much, Nalepa giving it as 0.2 mm. in the female, 0.175 in the male.

The larval stage is much like the adult, but the annulation and markings are not so distinct, and it exists in a semi-curved position buried in the substance of the galled tissues.

The earliest record was by Scheuten,‡ who called the supposed adult *Typhlodromus pyri*, this was nothing more than a gamasid mite, probably feeding on the Eriophyes, having no connection with the true gall former which was first named by Pagenstecher§ *Phytoptus pyri*.

Prevention and Remedies.

There is no doubt that this pest is spread in nursery stock, and it is therefore very essential that such should be fumigated before being planted. Hydrocyanic acid gas has been found quite effectual for this purpose at the strength used for fumigating young dormant stock. In small attacks in gardens, the galled leaves should be hand picked *as soon* as the signs of the disease appear ; by so doing in a year or so it will disappear. Slingerland has found in America that spraying with kerosene emulsion diluted with five to six parts of water, exterminate it, and Lounsbury has found the same of benefit at the Cape. This has been tried in Britain, and although it reduced the attack it did not by any means exterminate it.

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* Theobald F. V. Report on Economic Zoology for the year ending April 1st, 1906, p. 51 (1906).

† Parrott, P. J., Hodgkiss H. E., and Schoene, W. J., The Apple and Pear Mites. Bull. No. 283, New York Agricultural Experiment Station. (Dec. 1906).

‡ Scheuten, A. Trochel's Archives, p. 104 (1857).

§ Pagenstecker, H. A. Verhandl. Naturhist. Med. Ver. Heidelberg. Vol. I. p. 48 (1887).

In 1898 the kerosene emulsion, paraffin-napthalene wash and the lime-salt-sulphur washes were tried at Wye, and the latter proved * by far the most successful. Since then experiments in America† have conclusively proved that a modification of this wash namely, lime-sulphur-caustic-soda is best for combating this disease or the boiled lime-sulphur wash. Paraffin emulsion is advised where apple is attacked, diluted with five parts of water. This is best used in late autumn and early spring, and from observations made here either the lime-salt-sulphur or the lime-sulphur-caustic soda wash should be applied twice also in late November and in February.

It seems† much more difficult to control in America on apple than pear, particularly on account of the pubescence of the buds.

The lime, salt and sulphur wash is made as follows :—Lime 20 lbs., sulphur 15 lbs., salt 10 lbs., water 60 gallons. Slake the lime in water and stir in the sulphur ; then boil for an hour in half the quantity of water until a clear, reddish, coffee-coloured liquid is produced. Then add the salt and boil for fifteen minutes ; strain and dilute to 50 gallons.

The Gooseberry Red Spider (*Bryobia ribis* Th. or *prætiosa* Koch ?)

Throughout all the chief gooseberry centres the Red Spider is quite the worst pest that growers have to contend with. It is abundant some years much more so than others, but the exact factors which govern the rapid increase of this acarus are not known. It is generally said that heat and drought are responsible, but when one goes over a number of statistics and meterological records, this does not appear to be the case. The mites certainly feed

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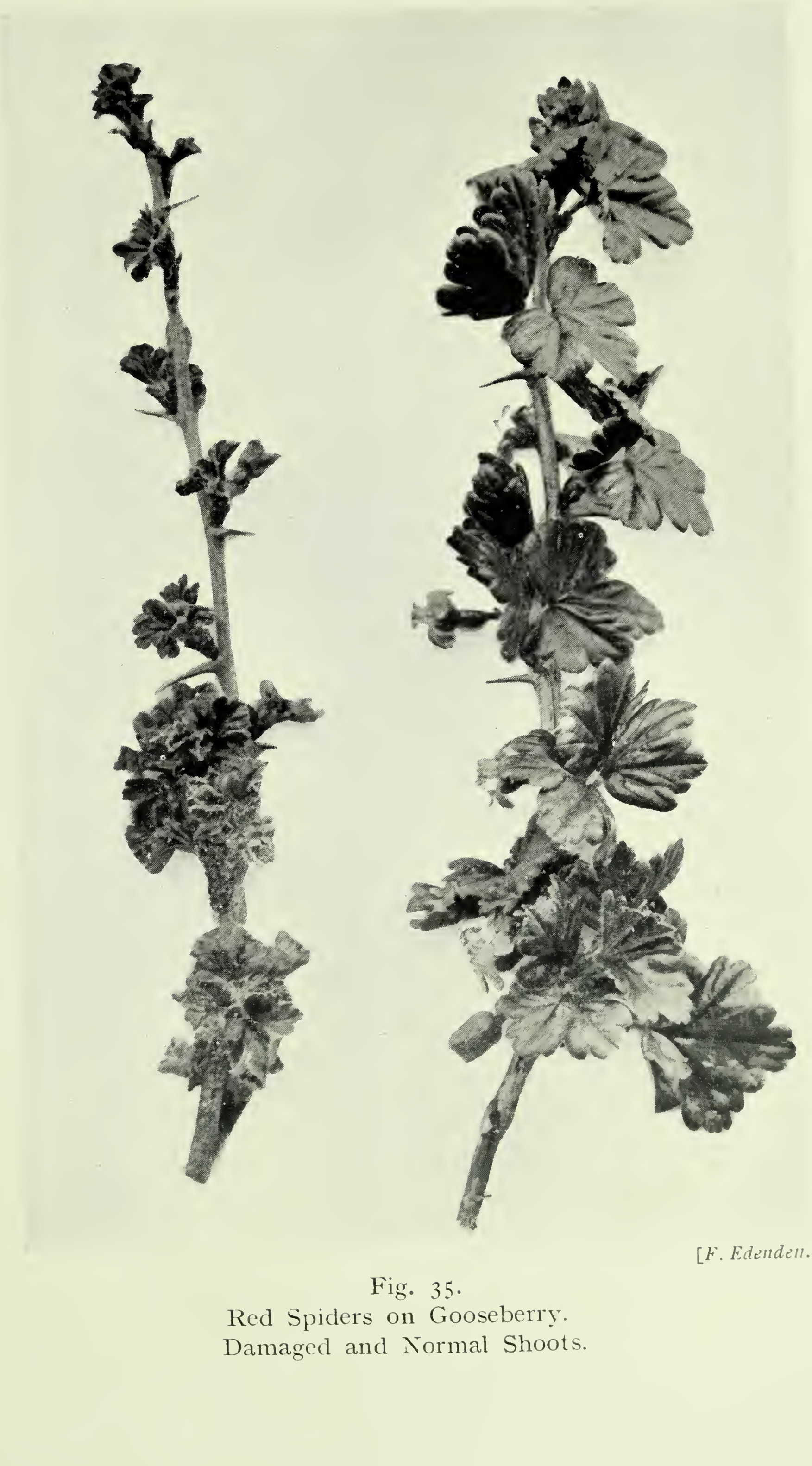
* Theobald F. V. *Journal of the S. E. Agricultural College*, No 7. p. 6 (1898).

† Parrott, P. J., Hodgkiss, H. E., and Schoene, W. J. The Apple and Pea Mites. Bull. No. 283, New York Agricultural Experiment Station (Dec. 1906).



[F. Edenden.

Fig. 35.
Red Spiders on Gooseberry.
Damaged and Normal Shoots.

more, and are more noticeable in warm, sunny, dry weather and the bushes are not so hardy, but there does not seem to be any excessive reproduction from those causes. Some of the worst attacks I remember have been after warm, damp weather. The Red Spider is, of course, not an insect ; it belongs to the eight-legged group of " joint-limbed animals," and to that section of them called *Acarina*. The young of these Red Spiders are very like the adult, but have only six legs, as the insect. They are oviparous, and the eggs are small, globular bodies, very similar to those of the Hop Red Spider (*Tetranychus malvae*).

The damage done by the mites is by their constantly sucking the sap from the leaves. The appearance produced is very marked : the larger leaves become marbled grey, sometimes almost silvery ; the young leaves are stunted in bad attacks, and present the appearance shown in the photograph reproduced here. The result is that the leaves and blossom, and even young fruitlets, fall off.

Complaints were received in April, 1907, from Mr. S. H. Little Borough Green ; Mr. J. Wood, of Crockenhall ; and Mr. Pollard, of Evesham. This is the month when the attack usually manifests itself to a serious extent.

This pest is well-known in Cambridgeshire, Worcestershire, Devon, Cornwall, Gloucestershire, Kent, Surrey, Sussex, Middlesex, and extends up into Scotland ; we may say practically wherever gooseberries are grown.

It has been described in various ways, some calling it *Tetranychus telarius*, one of the web-spinning mites ; others stating it is the same as the Red Spider on ivy, and calling it *Bryobia prætiosa*. Ormerod quoting Harker, refers to this mite forming silken webbing, " covering the whole of the ivy for quite one or two hundred yards," etc.

If this is the same species as she refers to on ivy in other places, it has nothing to do with the Red Spider of the gooseberry, for every grower knows that it does not form a distinct webbing. Although Michael says that it " swarms in millions on ivy in gardens," we venture to doubt, under the circumstances, that they are the same acarus. The mite on ivy does not agree with the common gooseberry pest, which is apparently *Bryobia ribis* Thomas.

Life-history and Habits.

This acarus belongs to the genus *Bryobia*, which is easily told from the Red Spider of plums, hops, etc., *Tetranychus*, by the first pair of legs being much longer than the rest, and all the legs much longer than in *Tetranychus*.

In colour this mite is very variable: some are grey, others greenish, others rusty red, some have red and brown coloration, yet others leaden grey or bright red, the legs are pale grey or dull pale reddish. In size, large mature specimens may reach nearly one-thirtieth of an inch. They collect in dull weather in early spring in crevices on the wood, or under the loosened skin on it. So densely are they often packed together, that they look like one red mass, their legs tucked under their bodies. I have noticed that in this stage they are frequently of a rich red hue, almost crimson lake. I have found them like this early in February, both in Kent and Cambridgeshire, in a semi-dormant condition. As soon as the young leaves show they are ready to move, the first warm sunny day they get onto the leaves and commence to feed and gradually mature. At night they retire to their shelter also on dull damp days. They generally feed mainly on the under sides of the leaves, but many on the upper, and the attack usually seems to start in the centre of the bushes and spreads outwards. In April or even March they may have started to reproduce, when minute round globular shiny reddish eggs with a few irregular pale hairs over them are laid on the twigs, base of the thorns, and on and between the old bud scales. These eggs, which can only be seen with a magnifying glass unless laid in large masses, hatch in four or five days into small semi-transparent young with six legs, these soon commence to feed; in another four days, moult and become very like the adult, two more moults appear to take place then at the end of twelve to fourteen days they are ready to reproduce again.

What happens between June and the following February I do not know, but one may find the immature mites on the wood at Christmas, and it is most probable that the eggs laid in June remain until late in the year, and that many if not all hibernate on the bushes. Again, what regulates their sudden increase, their equally sudden disappearance even in warm weather are subjects about which much further investigation is necessary.

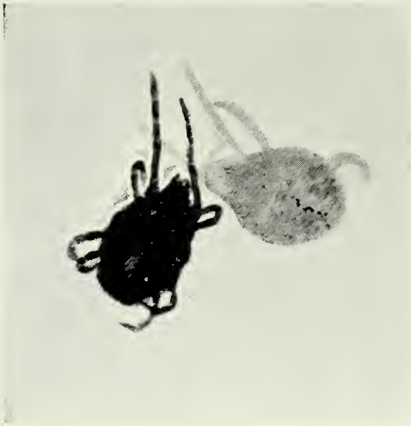


Fig. 36.
Gooseberry Red Spider (*Bryobia* sp.)
(greatly enlarged).

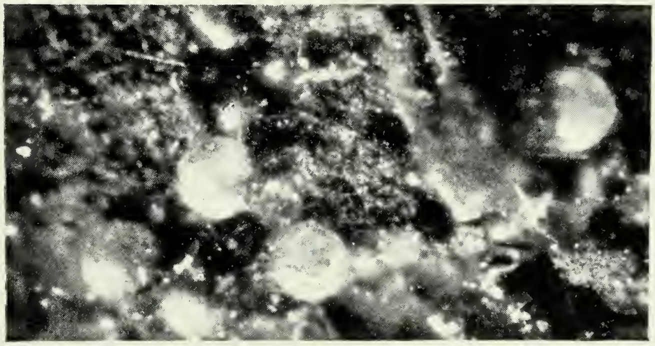


Fig. 37.
Empty egg-shells of Red Spider (magnified).

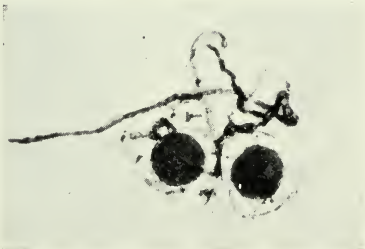


Fig. 38.
Ova of Red Spider (magnified).

The Red Spider of the ivy is quite distinct, it is larger and the white leaf-like processes instead of hairs are very marked. This *Bryobia praetiosa* which Ormerod records as the Gooseberry Red Spider is very common in ivy in Kent, but I have never seen it on the gooseberry.

Prevention and Treatment.

The recognised treatment for the Red Spiders has been some form of sulphur wash. Liver of sulphur has proved the most convenient form. It has however been found of no avail in certain years. For instance, in 1907 little good was done by spraying with the substance.

The other acaricide found to work when sulphur fails is paraffin emulsion, and the best results have been obtained with the paraffin jelly mentioned on page 118 of this report. Considerable success has also attended the use of nicotine washes, which I found most successful in 1907.

The question of preventing the attacks is one which growers naturally are most concerned with. As at present we have no definite information regarding the winter existence of this pest it is not likely that anything of a definite nature can be advised ; we do, however, know that the immature acari shelter in the crevices, etc., of the wood in February, and at this time a heavy spraying would be sure to kill very many. Mr. John Riley, of Putley Court, Ledbury, wrote me in 1902 that he had found great benefit from spraying with caustic alkali wash, and it is quite possible that this treatment in winter kills the hibernating acari. The action of caustic alkali wash certainly seems beneficial. Mr. F. Smith informs me that, last year, he also found it made all the difference. He had washed with 4 lbs. of liver of sulphur, 4 lbs. of soap, to the 100 gallons, and this did not kill the spider, but on adding 2 lbs. of caustic soda it killed them all right. Mr. Riley wrote again in April, 1907, saying there had been an awful attack at Putley Court, but it has been put down by spraying with 20 lbs. caustic soda, 5 lbs. of soft soap, to 100 gallons of water, just as the leaf was opening.

Washing, in any case, in February cannot fail to kill large numbers,and then a fairly strong paraffin emulsion may be used, up to as much as 5 gallons of paraffin to the 100 of wash has been found to do no harm, with the addition of the caustic soda.

Where attack only makes itself noticeable in April or May, then we must spray with either the liver of sulphur or the paraffin jelly, and it may be pointed out that to be of full value the bushes should be sprayed twice at an interval of about ten days, so as to kill any young which may have escaped from the eggs.

The paraffin-jelly mentioned may be made as follows:—Paraffin 5 gallons, soft soap 8 lbs., boil together and when boiling about 1 pint of water is added, and then well stirred.

This becomes a jelly when cold, 10 to 11 lbs. of which are added to 40 gallons of water.

The above amounts make about 160 gallons of wash. This formula used by Mr. Ballard, of Pinvin, will be found quite one of the best.

Slugs damaging Gooseberry blossom.

Several accounts of damage done to gooseberry blossom reached me in April. The blossom was eaten off in a somewhat similar way to sparrow-damage.

Mr. G. Hooper, of Pershore, wrote on April 10th that "The Whinham Gooseberry blossoms are being eaten off very badly just now, as you see by enclosed specimens. I don't believe it is slugs; anyway, they leave no trail, and none are ever seen. Mr. Pollard says it is sparrows, but personally I think it is some biting insect. Anyway, it is a very serious pest, and looks like clearing the Whinhams off up to now. It only apparently attacks this sort."

On April 11th, Mr. W. J. Dinnis wrote from Canterbury asking what caused the damage to the gooseberry blossoms sent "Last year I was told," says Mr. Dinnis, "that birds were the cause, but as I have carefully netted the bushes this year it cannot be birds."

Writing on the 17th of April, Mr. Hooper says, "I think there is no doubt now that the gooseberries are damaged by sparrows. It is curious that they seem to confine themselves to the Whinhams almost entirely. I have put ordinary lime over the bushes, and this seems to have been effective."

Writing again on the 19th, Mr. Hooper said, " You and Mr. Riley were right, it *is* slugs ; we caught them red-handed here, too, with the blossom attached to them. I think they climb up and drop down. I think salt sprinkled on the ground round the bushes will settle them."

The appearance of the attacked blossom is quite different to when sparrows peck them, which they undoubtedly do on certain occasions. The calyx is eaten sometimes only on one side, at others right down to the base. With sparrows it is the inside that is taken, not the calyx cup.

It has been found that ducks readily eat up the slugs, and may well be employed to clear them out in plantations that are being damaged by these molluscs.

ANIMALS INJURIOUS TO CORN CROPS.

An Attack of *Heterodera* in Oats.

Quite a new form of Eelworm attack in Oats was reported by Mr. W. C. Brown, of Appleby, Doncaster.

Specimens sent were at once seen to be attacked by a *Heterodera*, the rootlets being studded all over with little shiny white or brown globules, which proved to be the female eelworms.

Mr. Brown wrote that he had a fine piece of oats on his best land—red oolite limestone, but in patches they had gone off to nothing. He attributed this to be the result of frost on the very strong places, but eventually came to the conclusion it was due to other causes, and certainly not to the ordinary attack of Eelworm *Tylenchus devastatrix*.

Although the females exactly agreed with the *Heterodera*, which causes " nettle head " in hops, specimens were sent to Dr. Ritzema Bos, who kindly informed me that they were *Heterodera schachtii*, and that it is very harmful to oats in parts of Holland.

The plants showed no very marked signs of attack above ground, except that they were very stunted and gradually died; but on looking at the roots with a pocket lens, the nodular females gave a very characteristic appearance. Some two hundred females might be counted on a single oat plant.

The life-history of this nematode parasite was given in the last Report. The fact that it attacks oats in this way might be made use of in connection with " nettle head " in hops. The oats might be sown around infested hills with the object of drawing the worms away from the hop fibres; the young oats might be then dragged out of the ground, collected and burnt.

Some pot experiments were conducted by Mr. Rothwell at the College in connection with this. An infected hop set being placed in a large pot and oats sown in it; in another, hop fibres with the *Heterodera* were mixed with the soil and oats sown, but in no case did the oats become infested. It is quite possible, however, that the form on the hops has become fixed to that plant, and will not attack oats.

It is worth further trial, however, as if the oats will be attacked by the forms from the hops, they might be used to clear the ground when nettle headed hops are grubbed.

Tulip-root in Oats.

A number of cases of Tulip-root or Eelworm disease in oats were reported in 1907.

From Merstham, Albury in Surrey, one correspondent sent a sample of black oats with the following note: "We have about ten acres affected more or less, as the enclosed. They went a little patchy in May, but I found in June (end) they seemed to be dying right off, five or six acres in particular."

Another fifteen acres was also attacked in July, at Shalford, belonging to Mr. E. Ellis.

In Kent two bad outbreaks occurred at Ivychurch, one on land cropped with beans in the previous year, and another on land that had been down to tares; both these were in June. An outbreak was also reported from Gloucestershire by the Department of Agriculture of the County Council.

A whole field of oats was destroyed at Pett, in Sussex, by this eelworm. Mr. T. P. Dunlop wrote concerning this attack as follows:—"Swedes and thousand-head kale was the crop last year and the land was dunged for that crop. It was folded over during the winter, and the oats look much the best where it was folded in wet weather. The same seed oats sown in another field looked well." It is worth bearing in mind that folding sheep had here evidently some beneficial effect.

Enchytraeus Worms.

These worms were found attacking wheat with eelworms by Mr. Allington Collard, at Reculver, Herne Bay, in May. A piece of wheat was very badly attacked, it was supposed by wireworms, but on searching, Mr. Collard could not find any, but a number of the Enchytraeus worms, which he sent. They were mainly found congregated amongst the manure that had been ploughed in last December, the majority where the wheat plants were practically destroyed. Writing later, Mr. Collard said that the weather had been so favourable that the crop had grown away all right.

It seems from the information that is gradually being collected that these Enchytraeus worms are distributed not only in leaf mould, but also in farm-yard manure.

ANIMALS INJURIOUS TO GRASS LAND.

Larvae of *Dascillus cervinus* (Linn.) **in Ireland.**

The larvae of this beetle were sent to Mr. Emptage (who forwarded them to me), from Clondalkin, Ireland. They were reported as damaging grass.

The correspondent sent the following information :—" The grubs are in an old grass field that has not been ploughed for forty or fifty years, and are most in quantity when there is moss. As it is only this winter I noticed them in the ploughing, I cannot say very much about them. Frost does not affect them, nor do birds seem very fond of them."

The larvae were identified for me by Mr. C. O. Waterhouse, after much trouble, and have since hatched out.

This beetle is recorded as feeding underground in connection with the roots of orchids (Curtis, Brit. Ent. Vol. II.), and it was suggested that, perhaps, the larvae fed on the roots of orchids.

Mr. Waterhouse suggested that they might be enemies of the larvae of *Melolontha.*

The larvae were kept in pots with grass and moss, and in the pots were placed larvae of *Melolontha*, Wireworm, *Hepialus*, *Tipula* and young *Blanjulus.*

None of these were touched by them, but they continued to grow.

Mr. Jemmett found numbers of these larvae at the foot of the Downs at Wye, where they were evidently feeding on the roots of the tor grass. Amongst these roots in places was a little moss, and it seems that they also feed upon the tender rootlets of the moss, as well as grass.

There is no doubt that they are vegetal feeders, and are not carnivorous.

The occurrence on orchid roots may easily be accounted for by their feeding on moss, and in that way being taken with the *Sphagnum* to the orchids.

The beetles varied from 8 to 11 mm. in length ; they are elongated oval in form, covered with thick, fine grey pubescence, and with rather long, stout legs ; the male is smaller and narrower than the female, and is unicolourous black or pitchy-brown, with paler apex to the abdomen ; the female has a brown head and thorax, elytra, apex of antennae and legs slightly testaceous.

The beetles are said to occur on flowers, especially Umbelliferae, also on alders, brambles, etc. ; those taken at Wye have been mostly on rough grasses.

They hatched out from the larvae in mid June.

The larvae are yellowish to ochreous in colour and corneous ; somewhat contracted in form and slightly flattened. Fowler says they bear a strong analogy to the larvae of the *Lamellicorns*, but I fail to see this resemblance, for it is corneous in nature, and quite straight ; it has a large head and very powerful jaws ; the segments are marked, but those of the abdomen short, with the exception of the anal one, which is as long as the two preceding and terminates in two points. The length of the mature larvae just previous to pupation was three-fifths of an inch.

Fowler records them as appearing to live underground at the roots of plants, especially *Orchidaceae*, and also records the larvae in old pasture lands in Scotland. It is interesting to note that their presence in Ireland and at Wye was also in old pasture land.

The distribution according to Fowler, is as follows :—London district, Chatham, Box Hill, Leith Hill, Croydon, Mickleham, Caterham, Dover, Brighton, on thistles ; Devonshire, Drewsteignton, Dartmoor, Barnstaple ; Dean Forest, Swansea, Llangollen, Barmouth, Llanberis, Matlock, Scarborough, Northumberland and Durham district, Solway, Clyde, Tay, Dee and Moray districts in Scotland, Ireland near Belfast and Carlingford Mountain, on heather.

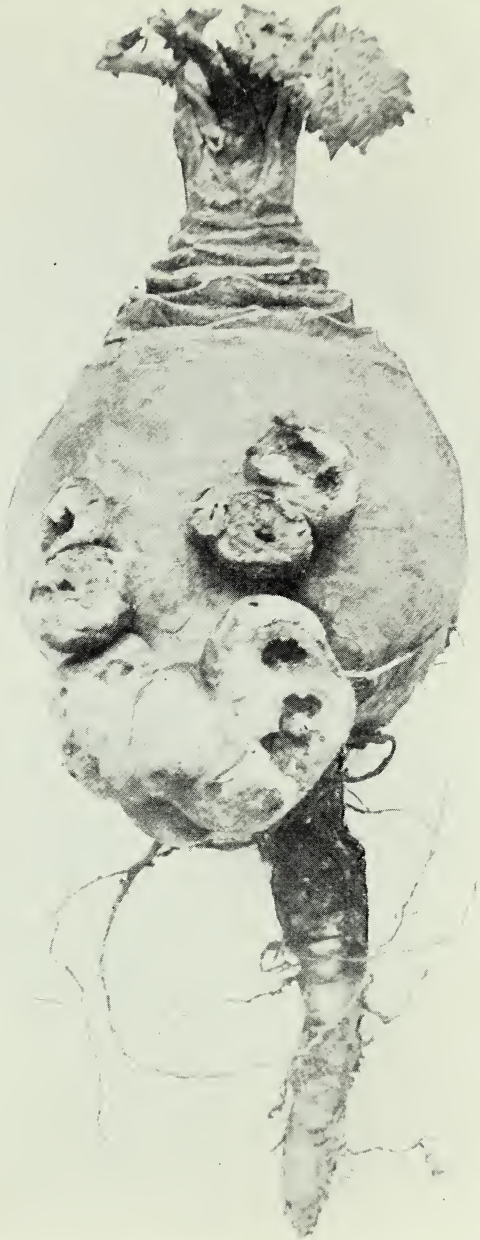


Fig. 39.
Turnip showing Galls of the Gall Weevil.
(*Ceutorhynchus sulcicollis*).

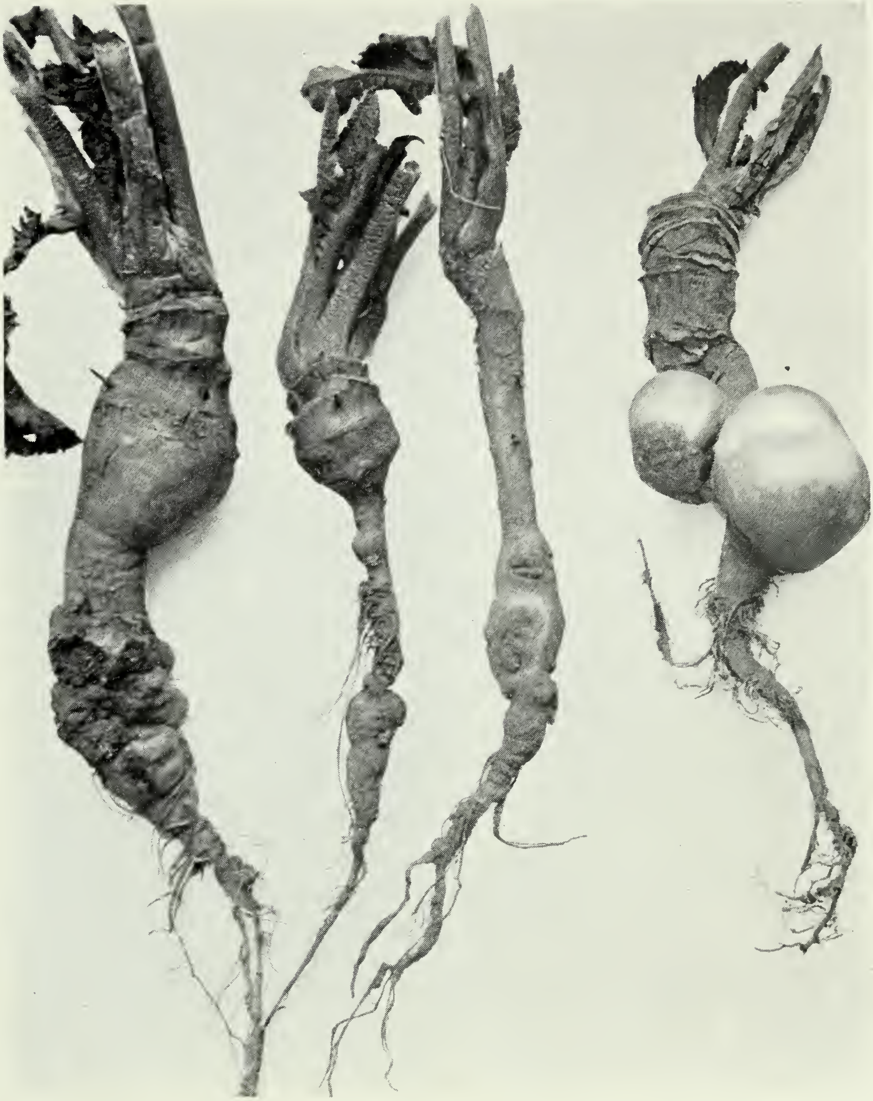


Fig. 40.
Turnips stunted by the Gall Weevil (*Ceutorhynchus sulcicollis*).

ANIMALS INJURIOUS TO ROOT CROPS.

Turnip Gall Weevil (*Ceutorhynchus sulcicollis* Gyll).

A bad attack of the Turnip Gall Weevil (*Ceutorhnychus sulcicollis*) was reported by Mr. Norman Galloway, of Mid Comp, Borough Green, in March, on swedes.

This insect was fully referred to in my last Report (pp.124-127).

It has also been found in some numbers damaging cabbage on the College Farm.

One notices that the usual thing done is to throw the cabbage stumps in a heap and let them rot and stink.

There is no possibility of keeping this pest in check where such slovenly habits exist. The active fermentation does not destroy these creatures in their pupal stage, and thus they hatch out and are ready to attack other cabbage or roots.

Pterostichus madidus (Fab) **attacking Mangolds.**

This ground beetle was found damaging mangolds at St Lawrence, Ramsgate. The correspondent wrote as follows :—"The Wurtzels are being eaten off at ground level, the beetles feeding in the evening and early morning. I have pushed," he said, "the earth close up to the plants with a shim, and they certainly seem better now, or else it is a shower of rain we had this morning which has cleared them out."

Further Observations on the Pigmy Mangold Beetle, 1907.

(*Atomaria linearis* Stephens.)

By R. N. Dowling, N.D.A., P.A.S.I.

This beetle was reported as doing damage to Mangel Wurtzel by Prof. F. V. Theobald in his "First Report on Economic Zoology" for the British Museum in 1904 (p. 8).

It was not again reported to be doing damage until 1906, when Prof. Theobald again records it in his "Report on Economic Zoology" for the South Eastern Agricultural College, 1906-7.

During this year, 1907, it has been very prevalent around the neighbourhood of Wye, in one instance completely clearing the first sowing off as soon as in leaf, and materially damaging the crop from the second drilling.

It is customary in this neighbourhood to drill mangolds in April, and as soon as the young plants showed well in the rows, the beetle made its appearance and started its attack.

During early and mid May, numbers could be found by lifting the plants and carefully examining the soil around the roots.

Towards the end of May and beginning of June, the beetles began to decrease in numbers, probably due to the adverse climatic conditions experienced about this time.

Contrary to previous reports, they have not been seen at night working on the leaves ; this again is probably due to exceptionally cold and unkindly weather.

The damage is done chiefly when the plant is quite young, that is, as soon as the young root starts to develop.

Generally the attack shows in the form of a little blackened spot on the root just below the surface of the ground, and if closely examined, appears like a little puncture of the tissues—the blackening being assumably caused by the oxidase "tyrosinase" present in the mangel. A great many cases, however, have been found, in which the damage was much lower down, and again in some instances where the attack showed signs of having been started as before, but instead of one spot, it appeared to start at the base of the root and work up, devouring the outer tissues and making a shallow elongated wound some $\frac{1}{4}$ in. to $\frac{3}{8}$ in. in length.

In the former cases, if the root was slightly bent, it would snap in two at the spot where the puncture was present. On close examination of a good many such cases, it was found that the damage did not extend right into the centre of the root, thus accounting for the apparently strange fact that although a crop was in one instance very severely attacked, yet it did not show any great signs of being retarded.

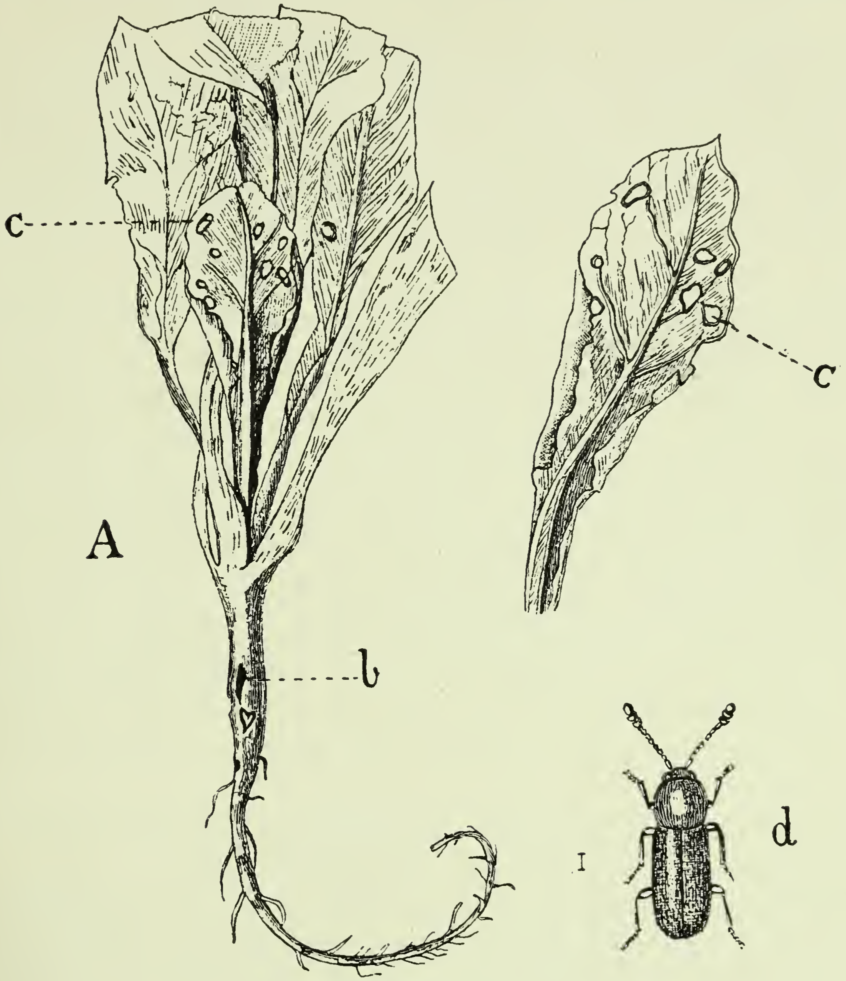


Fig 41.
The Pigmy Mangold Beetle.
A. Mangold plant, showing damage done by *Atomaria linearis* to root (b), and leaf (c); d. Adult beetle. (*From Second Report on Economic Zoology* (*British Museum*) F. V. Theobald.)

The mangolds that have suffered from attack at the lower portion of the root, if left alone make new growth, and the damaged portion simply withers away; if attacked just below the surface however, they go on developing until the "puncture" like wound becomes merely a speck on the outer tissues of the plant.

It was noticed that as the plants got bigger, the beetles seemed to leave them. This was ascertained in a field of "Globe" mangel, in one corner of which was a patch showing much finer growth than elsewhere, due to the fact that a dung heap was there the year before. The plants growing thereon were attacked as elsewhere, but as they reached from three inches to four inches in height the beetles left them. This fact was demonstrated even more satisfactorily among the main crops themselves, for by mid June, when the plants had reached a fair size, hardly a beetle could be found on the crop.

The variety of mangold grown does not seem to make any difference, for both Tankards and Yellow Globes were badly attacked, neither do different soils seem to alter matters, for bad attacks were experienced on very light chalk to heavyish loams.

The following interesting fact was noticed. In one corner of a field of mangel, the crop looked much better and more forward than elsewhere. On inquiry it was found that what was thought to be an error had befallen the lot of this particular piece. It was rolled when apparently too wet, with the result of a more or less panning effect, and therefore the seed was drilled in a hard firm seedbed.

It is suggested that the free movements of the beetles were minimised, and consequently the crop suffered less.

If the above suggestion is accepted as being correct, then it is reasonable to assume that such treatment, *i.e.*, heavy rolling and consolidation of seedbed, might have the effect of preventing damage where the beetles are present in large numbers.

Observations have been made to ascertain whether the beetles hatch out as larvae in the soil. Boxes were prepared and filled with soil, mangels from the field crops being planted, together with numbers of the beetles, the whole being closely covered with fine muslin. The plants were attacked, but the beetles disappeared about the end of June. The earth from such boxes was very carefully examined over white paper, but not a trace of a single beetle could be found, showing that they must have died and decomposed.

One larva only was discovered, and this has been carefully recorded, and it is hoped that if it pupates and hatches out, a definite knowledge as to the characters of the larva of the Pigmy Mangold Beetle will have been gained.

A complete description of the beetle can be found in the Rev. Canon Fowler's book on the "Coleoptera of the British Islands," Vol. III., p. 333, also he states that the beetle is rarer in the northern parts of England. This corresponds with the fact that they disappeared this year during the cold weather. Also in the same report it is stated that they are found in moss, haystack refuse, etc.

Many crops were examined during the present research to ascertain if the beetles migrated from the mangold, but without result. During July, however, the writer was fortunate enough to come across a great number flying about on a warm afternoon, above rough, coarse grasses, situate in a clearing in the midst of a wood, being one-third of a mile away from the nearest mangold crop. They have been seen many times since, and thus it would seem that as the mangold crop gets to some three inches or four inches in height, the Pigmy Mangold Beetle migrates to rough herbage and grassland.

R. N. D.

Surface Larvae attacking Roots.

Soil grubs of many kinds seem to have been harmful since the last Report. Amongst various attacks may be mentioned considerable damage done by Surface Larvae, the caterpillars of the Heart and Dart Moth (*Agrotis exclamationis*) to carrots and swedes at Shalford.

The Surface Larvae are the caterpillars of several kinds of Noctuid Moths, such as the Heart and Dart Moth (*Agrotis exclamationis*), the Turnip Moth (*Agrotis segetis*), and the Large Yellow Underwing (*Typhaena pronuba*). They all work in a very similar way, that is below ground on the underground part of the stem, or on the roots. Where they attack turnips they frequently burrow right into the root and then decay speedily sets up.

Frequent hand and horse hoeing is about the best thing to do to check the damage, and the encouragement of rooks, starlings and green plover, all of which feed upon these larvae. A good dressing of soot also makes the land obnoxious to them.

The larvae may also be poisoned by placing heaps of clover or lucerne steeped in Paris green or arsenate of lead about on the ground or just under it.

ANIMALS INJURIOUS TO PULSE.

Eelworm in Pea Roots.

A bad attack on eight acres of peas by Eelworm (*Tylenchus devastatrix*) was reported from Kingsley, Alton, Hants, in 1907. The roots and stem near the ground decayed, and the crop gradually failed in places. The eelworms were found in quite sound-looking plants, which gradually rotted away in a few days. Quite healthy seed was sown in pots, and those which had the decaying matter and eelworms put with them, became infected in a few days, and were decaying away in two weeks. A similar attack was noticed in June, 1899, at Hoo. The plants were in bloom, and were seen to be turning yellow over a large part of the field. An examination showed the stems to be decaying away, from the ground upwards, and to be full of eelworms internally. The ten acres which were attacked were almost totally lost. I was unable to infect other peas with the eelworms at that time (*Journal* S.E.A.C., April, 1900, No. 9, p. 47).

Pea and Bean Weevils (*Sitones lineatus* Linn).

In the south of England this pest was not so destructive as usual in the spring of this year (1908).

It appeared, however, in very large numbers in parts of Lincolnshire.

The Hon. J. M. Campbell wrote in May, from Wragby, for information concerning these beetles, which were appearing in swarms on the field beans and doing much damage.

The best way to check its ravages on peas and beans is to roll them when young when the ground is in a fit state, so as to compress the soil and crush all clods beneath which the beetles shelter in inclement weather. A good dressing of soot should follow.

ANIMALS INJURIOUS TO HOPS.

Eelworms in Hops (*Heterodera schachtii* Bos).

This disease continues to spread year by year, and at present we have not any definite means of preventing it. The various ground fumigants that are advertised will not do as far as I have been able to observe. A few nematodes are killed where they actually come in contact with the insecticide, but not one in a thousand are touched by it, and the fumes (?) do not seem to have any effect. At least they do not do so in the laboratory, so they are scarcely likely to do so in the open.

The eelworm causing Nettle Head (*Heterodera schachtii*) has also been found damaging oats in Yorkshire (*vide* p.150).

It is common in Kent and Worcestershire. During the past year Mr. Wm. Rogers, of Horton Kirby, near Dartford, wrote that " Last year a few hills were affected, and I was told that a strong solution of nitrate of soda or sulphate of ammonia, say 1 lb. to a gallon of water soaked into the hill would effect a cure, but it did no good except to stimulate the plant, and in some cases kill it ! "

The eelworms live not only on the rootlets in the hill, but all over the ramifying fibres, and may be in small numbers on several plants, so that if any treatment is to be successful it must extend a long way around the affected hill, at least for about two hills all around. Sulphate of ammonia is fatal to most eelworms used at the rate of 1 to 2 cwt. per acre.

Mr. Hubble, of Hunton, near Maidstone, also reported the spread of this disease in his gardens.

In Worcestershire, it was further reported by Mr. J. H. W. Best from his plantations at Suckley, where it keeps spreading.

Eelworm attack of all kinds is undoubtedly worst on land deficient in lime and in consequence a good dressing of lime has frequently been found to check the ravages of these nematodes. This might be tried on hop land where nettle head is present. At the same time growers might try sowing oats here and there where nettle-headed hills have been grubbed, and pull some and send to the College for examination when they are about six inches high, since this *Heterodera* has been found in this country infesting oats just as it does in Holland.

Julus Worms (*Julus londinensis*) in Hop Hills.

Mr. Frederic Neame sent specimens of the so-called Thousand Leg (*Julus londinensis*) to the College, in April, with the following note :—" I am finding a quantity of black worms near the hop hills in some of my gardens. I am having them picked out with the wireworm and destroyed. I am wondering whether they are injurious or whether they may be on the other hand doing any useful work."

It is extremely doubtful if this Julus does any harm. It appears to go to any decaying or unhealthy roots or vegetation above ground, and as far as we know does not feed on any sound tissue.

There is not sufficient evidence yet to show that any of the *Julidae*, even the Small Snake Millepede (*Blanjulus guttulatus*) does damage. Writing this year, Mr. F. O. Walker, of Ulcombe, says he is of opinion that these *Julidae* only go to rotting or decaying roots, and I am now inclined to think this has always been the case.

The Hop Flea (*Plectroscelis concinna* Marsh).

A bad attack of Hop Flea was reported from Borden Hall, near Sittingbourne, by Mr. Lewis Levy. Soot had been previously tried, but was found utterly useless, and shaking over tarred boards was resorted to.

Most serious attacks of an allied species have been taking place in British Columbia, whole gardens being eaten down by the flea beetles.

No remedy yet devised has proved successful, but the presence of these flea beetles may be very much lessened by keeping poultry in the gardens when the bine is starting and onwards until it is well up to four or five feet. Chicks feed ravenously upon the flea beetles, and in several cases have been found to clear them out.

A New Hop Pest (*Entomobrya nivalis* Linn.).

This very common apterous insect may be found on all kinds of plants. One can get specimens by beating low trees, furze, heather, etc., and it also occurs commonly under bark of trees, where it probably lays its eggs, as well as in moss and damp grass, and under stones. It is also known as *Degeeria annulata* Lubbock.

It occurred in July, 1907, in very large numbers in a hop yard at Chilham, and did considerable damage.

Mr. Edward Leney wrote on July 17th as follows :—" When at Chilham yesterday I found a small hop garden at Cork Farm being eaten up by something, although I could discover nothing but small black insects like ' Thunder Bugs ' (*Thrips*)."

On the 18th and 19th, the garden was visited, and it was at once seen that the burr was rapidly being cleared off. The attack started at the tip of the branches, and in many the damage extended down to the lower parts. Most of the burr was ruined in places, and the damage showed all over the garden. The bine had also been damaged where tender.

An examination soon revealed numbers of the small Springtail, which Dr. Carpenter identified for me later. Some of these small *aptera* were to be seen at work on the hops, very many more on the ground. They were very shy, falling or springing to the ground at the least movement. I learnt from the bailiff that the damage seemed to be done mainly at night. Quantities of the insects were found sheltering under clods of earth in the day time.

There was no doubt as to the cause of the damage. This is, however, the first time this Springtail has been recorded doing harm to hops.

The garden was washed with soft soap and quassia, then sulphured and washed again with quassia and soft soap.

The soil was also well dusted with lime.

This seemed to have checked the damage; but on the 23rd, Mr. Leney wrote again and said damage was still being done, "the burr still being eaten off, I am going to wash with a strong solution of bitter aloes."

Mr. Arthur Amos suggested smearing the lower part of the bine with molasses so as to prevent the insects reascending after they had been jarred off.

Fever Flies (*Bibionidae*) on Hop Roots.

Great numbers of these flies have occurred during the past spring all over the country.

In March, Mr. W. Hubble sent hop roots badly attacked by these maggots. He informed me that many hills in the garden were apparently killed by them, which had not come under his notice before.

They proved to be *Bibio hortulanus*, which attacks a great variety of roots. Other reports of the damage done to hop roots by them have also been received.

They may be trapped by moist roots put in the hills.

ANIMALS INJURIOUS TO VEGETABLES.

The Celery Fly (*Acidia heraclei* Linn).

One of the worst attacks of the Celery Fly I have seen took place last year. It was general all over the country, large quantities of celery being entirely killed by the leaf mining maggots.

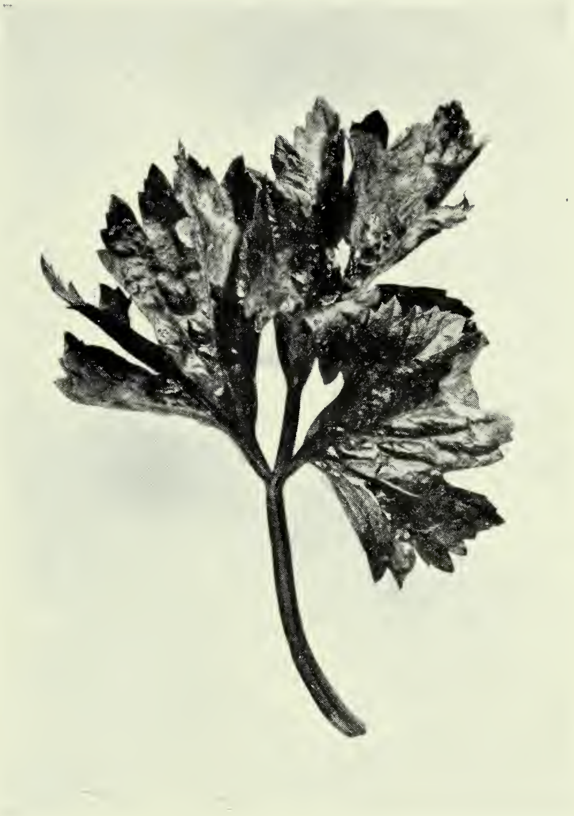
A correspondent writing from Haslemere, in February, stated that celery had been quite a failure there that season ; another wrote from Lyminge, saying the same, and others from near Guildford and Godalming in Surrey.

A third brood of the flies appeared in enormous numbers in the end of July, and in the beginning of August.

Some rows were sprayed at Wye, with the following :—Paraffin emulsion, liver of sulphur, soot water, and two patent insecticides. None of these had much effect, but there was less attack on the rows sprayed with paraffin emulsion next to two check rows, one on each side.

Two rows were swept with a butterfly net on a bright day when the flies were seen about. No less than 150 flies were caught in ten minutes on the two rows, which were forty feet long. Both these rows presented a healthy appearance later, and showed no signs of attack, and yielded a good crop, whilst the sprayed and unsprayed rows were so badly attacked that the celery was small and bitter, several of the rows not being dug at all.

It thus seems that where we can notice the appearance of the fly, and it varies considerably, catching the flies well repays the small outlay. It could be done by boys or women, and a considerable amount of ground can be covered in the day.



W. H. Hammond.

Fig. 42.
Celery Leaf attacked by Celery Fly Maggots

Spraying with Voss' Tobacco Extract Wash was tried, and so far has yielded good results, but further trials are necessary before we can say that it kills the maggots in the leaves.

Rust (Fly) in Carrots (*Psila rosae* Fab.).

Two attacks of Rust in carrots have been reported and information sent concerning this pest, which is a fly known as the Carrot Fly (*Psila rosae*). Mr. Jan Forbes Robertson wrote in January from Farnham that the carrots on some freshly broken land had all become attacked and destroyed by a yellow maggot, which was seen to be the Carrot Fly Maggot.

The other case was reported by Mr. W. D. Marlow, from Teddington, Middlesex. The latter gentleman wrote that " the carrots when taken up were good and sound, except that the very fine part of the tap root, which had gone off as though it had a kind of rust. They were stored in a brick shed with dry sifted coal ashes, and now they have nearly all gone off as those sent. They are similar to those sent you in August which arrived when you were away. I noticed that many of the leaves went yellow. I have always for years past sown early French carrots in August, and so have been able to pull young carrots up till spring, but this last season has been a failure. I noticed about six weeks ago that many of their leaves went yellow, but took that to be the effect of frost until I saw the sparrows pecking around them, and on going to see what the birds were about, found to my great disappointment that the carrots were infested with white maggot, so badly that I pulled them all up and burnt them. Then I made a strong solution of soft soap and paraffin, and saturated the bed and now I have trenched the ground three feet deep. All the carrots show a peculiar kind of rust."

Some recent experiments have shown that a heavy dressing of road dust, or fine earth, and washing soda broadcast over the plants after thinning has a decidedly beneficial effect. The proportions used were one part of washing soda finely crushed to ten parts of earth.

Carrots showing signs of premature leaf colouring should be pulled and destroyed, and the holes filled in with the earth and soda, or with Vaporite, which we have found of use for this pest and the Onion Maggot.

Land where carrots have been grown, if affected with rust should be deeply trenched in winter.

The Onion Fly (*Phorbia cepetorum* Meade).

This well-known garden enemy was not as prevalent as usual in 1907. An inquiry came, however, from Mr. Jan Forbes Robertson, from Farnham ; in his letter he stated as follows :—" I have a piece of ground of a very sandy nature. Last year I grew potatoes on it. This year I have onions and carrots. The onions have been entirely destroyed by a white grub. The piece of land was trenched three feet deep in winter."

This communication came in August. The Onion Fly manifests itself prominently in early July, but I have known young spring onions destroyed in May.

The application of washing soda has again proved beneficial, lightly sprinkled along the rows.

Vaporite was also tried this year, but the smell prevents it being employed except in the very early stages of the plants, numbers of the maggots were undoubtedly destroyed by it, but no more as far as one could judge than by the washing soda.

ANIMALS INJURIOUS TO FLOWERS.

The Garden Swift Moth (*Hepialus lupulinus* Linn.), **damaging corms, etc.**

This common insect was sent from Ramsgate, by Mr. W. C. Bull with a note that they were damaging his gladiolus corms. The grubs were not as abundant as wireworm, but Mr. W. C. Bull says, "a couple of them will in the course of a few weeks, especially in October and November, destroy hundreds of corms by gnawing holes in them, which start a rapid rot, they bite a hole in all they can get to."

Later, Mr. Bull wrote that he had tried Vaporite for keeping wireworm off, but he found it useless, though it suppressed a plague of millipedes (*vide* also on Strawberry, p. 89).

Rose Maggots.

Numerous complaints have been received from different parts of Britain, but especially from around London, of the damage done by Rose Maggots.

These are the larvae of several small moths, including the Red Rose Maggot (*Pardia tripunctata*), Brown Rose Grub (*Spilonota roborana*), and the Green Rose Maggot (*Tortrix ribeana*).

These destructive larvae which eat into the blossom buds, gum others up with moisture and frass, and do so much harm, may easily be checked by spraying with arsenate of lead, but it must be applied early: that is, when the grubs are quite young, not later than the end of April, and again the second week in May. Sometimes a third spraying is necessary.

For this purpose it is best to mix one's own arsenate of lead, as I find that Swift's Paste colours the leaves rather badly, and makes them unsightly. The arsenate of lead may be mixed as follows :—Arsenate of soda (pure or crystalline), 3½ ozs. ; acetate of lead, 7 ozs. ; water, 10 gallons. This readily mixes, and does not to any appreciable extent colour even delicate foliage.

The Leaf Rolling Rose Sawfly (*Blennocampa pusilla* Klug).

A very bad attack of this sawfly on roses was reported by Mr. Legge, of Nutfield, Redhill.

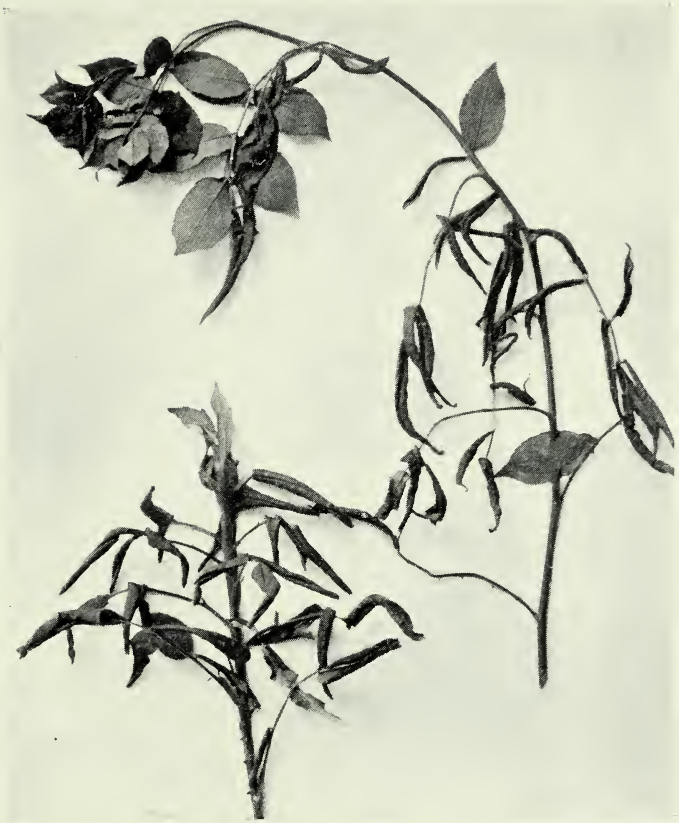
This insect is very common on wild roses, and may easily be detected by the lateral rolling up of the leaves. On opening the rolls, numbers of green sawfly larvae are to be found within.

The cylindrical rolls are due, as far as I could detect, entirely to the larvae, but Cameron says that the female sawfly aids in their formation by the incisions made when laying her eggs.

This insect was referred to in my last Report (p. 125) as being rare on cultivated roses. This statement must be modified, for during the last two years quite a number of attacks have taken place. Besides the Marechal Neil, many other varieties appear to be subject to it.

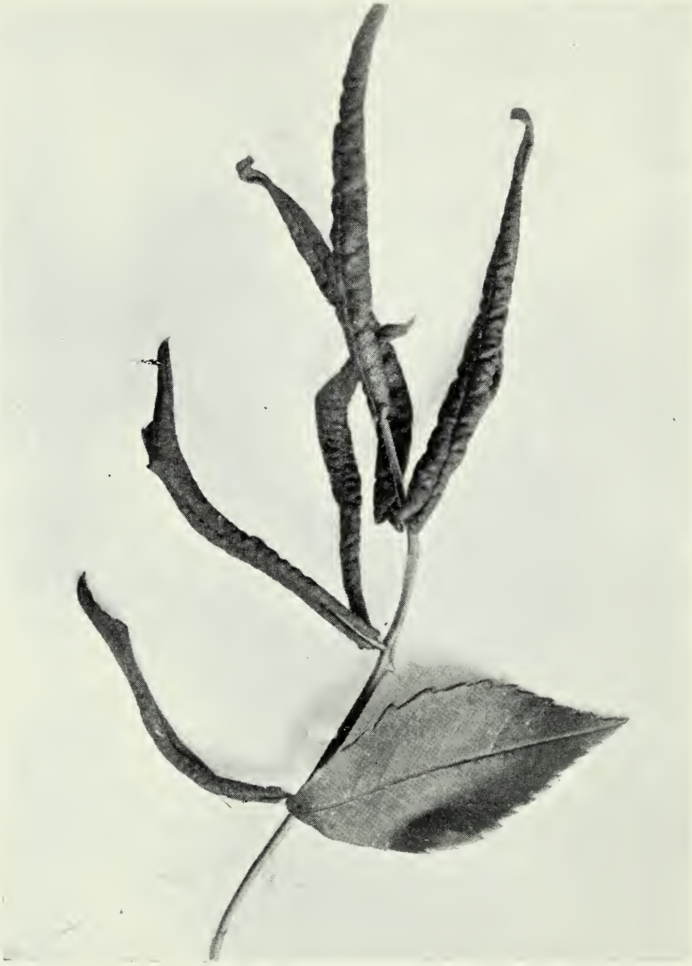
Mr. Legge's account of the attack of the Sawfly at Redhill is as follows :—" The first signs I saw of them was in the summer of 1904, when I saw a few curled leaves on a plant of M. Dickson ; I had the leaves picked and burnt. The leaves that came out on the top of the shoot were quite normal. Again, last year we had the same trouble, it making its appearance on exactly the same plant, and almost on the same date ; on referring to my note book, I find it was found on May 28th, 1904. The same plants were the first to show signs this season—1907.

" Circumstances would not permit of preventive measures being taken ; consequently a number of other plants have been attacked in a like manner. The following roses have been attacked : Margaret Dickson, Claire Jacquire, William Allen Richardson, Reine Olga de Wurtemburg, Captain Hayward, Captain Christy, Francesca Kruger, Marie van Houtte, Isabella Sprunt, Jules Finger, La Soliel, Baroness Rothschild, Bouquet d'Or."



[F. Edenden.

Fig. 43.
Rose Shoots attacked by *Blennocampa pusilla* Klug.



[*F. Edenden.*

Fig. 44.
Rose Leaves curled by *Blennocampa pusilla* Klug.

These larvae are very delicate, and I found many were destroyed by dilute paraffin emulsion.

Fever Flies (*Bibionidae*) and *Muscid Larvae* attacking pot plants.

Messrs. Butler Brothers, of Burr Farm Nurseries, Bexley Heath, forwarded a number of Bibio larvae and some Muscid maggots, which they found very troublesome during the winter months in pot plants, particularly the winter flowering marguerites.

Unfortunately, neither hatched out, so that the species could not be diagnosed.

A Begonia Aphis (*Aphis opima*).

Some begonia plants were received in February from Warlingham, Surrey, with the following note :—" I send some begonias (Gloria de Lorraine) for examination, to see if the disease is due to an insect, but I don't think it can be an insect because I fumigate with the 'XL-all.' When they are attacked they lose all their leaves, as you will see by the stems I have sent."

The plants were smothered with the aphis known as *Aphis opima*.

Thrips attacking Roses.

The gardener at Mereworth Castle, Maidstone, forwarded on July 18th, some badly damaged rose buds, with the following information :—" They were attacked by mildew, but I used sulphur for it ; we think that mildew may be the cause."

An examination at once showed that no mildew was present, but that great numbers of Thrips were living in and about the buds.

The Thrips on the rose is *Thrips vulgatissima*. It causes a pale marbling of the leaves, as well as damaging the blossom buds. The insect is about one-twelfth of an inch long, black with pale legs, four long wings edged with long fine hairs ; the larvae are wingless and reddish yellow, with head, part of thorax and apex of the body dark. The eggs are laid on the foliage.

Thrips may be kept down by syringing with plain cold water but tobacco wash is the best remedy. Voss' Tobacco Wash, as recommended by the Woburn Experiment Station, was found quite successful this season, used at half the proportion recommended.

Ants.

Several inquiries have been received this past year concerning ants, and reporting the damage done by them.

In September, an inquiry was received with the following note :—" The piece of ground I grow my carnations on has quite lately become infested with ants. They have got into the calyces of the flowers as they came out, and all the petals dropped out (bitten off at the base) in consequence. I have got half through the layering, but find such a quantity of little white eggs (cocoons) in the ground, that I fear the plants may be destroyed by the pest."

The damage done to roses by ants has also been reported from several places ; they apparently feed upon the tender blossoms, and have been watched at work on them ; the blossoms then flagged and turned brown. Ants frequently occur on roses when aphis is present, but do not then seem to do any harm : they merely collect the sweet honeydew.

Besides flowers, ants have been recorded attacking vegetables, taking up their abode amongst the roots of French artichokes, etc., and killing the plants. Fruit trees have also been attacked. Some freshly-grafted pears under observation had all the buds destroyed by them. Complaints of their damage to lawns and garden borders have been received from the London district, where they occurred in numbers in 1907, and worse still this year.

Ant hills may soon be rid of the insects if a hole is made in them and a couple of ounces of disulphide of carbon poured into the hole, and at once closed up with earth or clay.

Vaporite has also been found most successful in killing the ants in the loose mounds formed in herbaceous borders, and also in soil where they were working amongst flowers. Two applications, however, are necessary, as the pupae are in no ways affected by it or the disulphide of carbon.

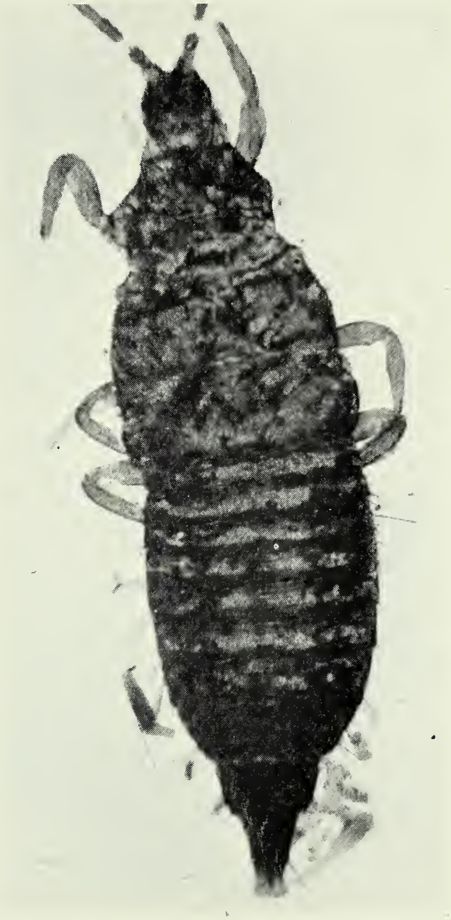


Fig. 45.

The Pea Thrips (*Thrips pisivora*).

(Greatly enlarged.)

Similar in *general appearance* to Rose Thrips.

Red Spider on Ivy (*Bryobia praetiosa* Koch).

Some inquiries have been made about the Red Spider on ivy. Colonel A. C. Boston, of Cheveney, Hunton, Maidstone, wrote in July regarding the numbers found on ivy there. It was also reported from Barmouth, North Wales, near London, and near Guildford in Surrey. Great numbers occurred on ivy at Wye from May to July, when they disappeared.

This species found attacking ivy is not at all the same as the Red Spider attacking the gooseberries in Kent or Worcestershire as stated by Miss Ormerod. The ivy species has broad, leaf-like white spines on the body ; the gooseberry species has these in the form of bristles.

Moreover, experiments were made to see if the species from the ivy would breed on the gooseberry, although great numbers were transferred to the bushes in my garden they would not grow or live on them.

Ground Mealy Bug (*Ripersia terrestris* Newstead).

This pest, which I dealt with in the Report for 1905, was reported by Mr. Hammond, on the roots of a palm, in October. The roots sent were quite white with this insect.

Fumigation with disulphide of carbon after the plants have been removed from the pots and well soaked in water was found the best treatment, but placing them in a closed box and subjecting them to the strong fumes of benzine was equally successful.

ANIMALS INJURIOUS TO FOREST TREES.

The Giant Wood Wasp (*Sirex gigas* Linn).

Specimens of the Giant Wood Wasp (*Sirex gigas*) were sent from Swaledale, Yorkshire, in August. This insect appears, from the information sent, to be very rare in that district.

The Holly Shoot Moth (*Steganoptycha* (*grapholitha*) *naevana* Hb.).

This small moth in its larval stage was inquired about last year, but no information could be given until the moth was bred out.

The inquiry came from Swellfield, near Walsall, where the pest has been appearing for some years doing a good deal of harm to holly hedges, etc. The shoots to some extent seem bored and eaten, but the chief damage is done by the caterpillars eating and spinning the young tender leaves together at the tips of the shoots and killing them. The small caterpillars sent were of a dull dirty green with black head and a black shield on the segment next the head. They reached from 8 to 9 mm. in length when mature, and pupated in loose cocoons amongst the dead shoots.

The moths hatched out in July, and one or two as late as August.

The adult is about two-fifths of an inch in wing expanse; the fore wings are pale greyish-brown, with a basal dark brown patch enclosing a dull paler spot on the inner margin, and beyond the middle an oblique brown fascia, from the middle of which a dark spot protrudes towards the apex; the hind wings are uniformly pale brownish-grey.

Gillanders in his "Forest Entomology," refers to another species *Paedisca opthalmicana* Hub., as affecting holly hedges in May or June, drawing the leaves of the terminal shoots together with silk in a similar manner. The larva, he describes as also being dirty green with a black head and shield. There are probably several such holly feeders.

The hedgerows at Smellfield had been sprayed with petroleum emulsion, but had not been cleared by it.

A good early washing with arsenate of lead would prove more successful.

Small attacks may easily be cleared by nipping off the attacked tips and destroying them and the caterpillars.

The Pine Shoot Moth (*Retinia buoliana* Schiff).

This pest was reported on Scotch Pine, from Godalming, in October, the shoots being very much deformed by the working of the larvae, the leading shoots of many of the young trees being destroyed. It also attacks Austrian pines in the same way, especially those of about ten years' standing.

The moth is not quite an inch in wing expanse, to a little over three-fourths of an inch ; the front wings are rusty red to reddish-yellow in colour, with silvery transverse irregular lines very variable in form ; the hind wings are uniform smoky-grey ; the thorax yellowish-red and the abdomen silvery grey.

The moths hatched in mid July, and are found as late as the first week in August. They lay their eggs on the tips of the shoots. The larvae hatch in late summer and eat the shoot, causing a resinous exudate and beneath this they hibernate all the winter.

In early spring they leave the resin chamber, and tunnel into the shoot, where they feed until July, and then pupate. The larva is about half-an-inch long, brownish in colour, with a darkened head and legs, whilst the pupa is pale brown with darker wing cases. The pupal stage lasts about two weeks.

Nothing can be done to check it but hand-picking the attacked shoots.

The Euonymous Little Ermine (*Hyponomeuta evonymella* Linn).

A considerable amount of this tent caterpillar was noticed all over East Kent, in 1907.

Mr. J. Harvey, writing from Nonington on May 20th, sent a box containing a large tent figured here, containing hundreds of caterpillars, cut from a hedge along the roadside, and stated that there were large quantities of them extending some fifty yards or more. The same could be seen along many of the roads in East Kent, the hedges being covered with silken webbing.

This species does not often attack fruit as far as we know, but is sometimes harmful to ornamental *Euonymus* in gardens, etc.

The normal food plants are the Spindle tree (*Euonymus europaeus*), and the Bird Cherry (*Prunus radius*).

It has been found, however, spreading on to cherry trees, where the hedgerows are smothered with it. It is therefore wise to destroy all the tents seen, to prevent any possible invasion of our cherry orchards.

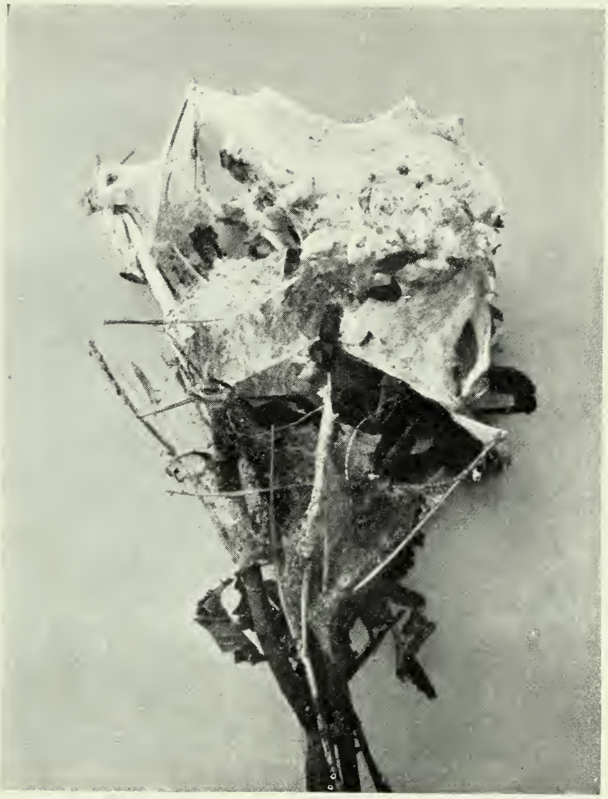
The perfect insect appears in July and August ; those from the tent figured commenced to hatch on July 20th and went on doing so until August 4th. Some hundreds hatched from this single tent. It is very similar to the apple species (*H. malinella*) in general appearance.

The Larch Shoot Moth (*Argyresthia laevigatella* H. Sch.).

The insect recently drawn attention to by Dr. Wm. Somerville (Quarterly Journal of Forestry I., No. 3), was reported from Panton, Lincolnshire, last June, and the attacked plantation was visited in company with Mr. Orwin.

This small Tineid Moth was not recorded in Britain previous to Dr. Somerville's notice, but it has probably existed all along here, and will now be found in many places since attention has been called to it.

The damage done by the larvae is very marked, but may easily be confused with other diseases unless carefully examined. The tops of the shoots die right back, and become very noticeable ; if this is due to the attack of this small larva, then the working



[*F. Edenden.*

Fig. 46.
Nest of *Hyponomeuta evonymella*.

can be seen partly as a swelling, with a more or less prominent hole through the skin, and frass exuding, sometimes resin. Some of the shoots examined at Panton were markedly bent at the damaged area, others remained quite erect ; the length of shoot killed varied from a few inches to nearly one-and-a-half feet. Not only the leading shoots were attacked, but many of the lateral ones also.

Exactly the same appearance I have seen in a larch plantation at Wye, but an examination at once showed that the cause was not due to the *Argyresthia*, but to Larch Canker.

The moth is quite small, and may easily be mistaken for that of the Larch Coleophora (*Coleophora laricella*) ; the front wings are shiny silvery-grey to leaden grey, the fringes grey to brownish grey, the hind wings appear somewhat darker and duller ; thorax and abdomen grey, and there are pale hairs on the head, sometimes grey, at others creamy. The length varies from 10 to 12 mm. in wing expanse. The moths were found on the wing at Panton, in June, and were flying about in numbers in the late afternoon.

The eggs are laid on the lower part of the new shoots, and the little pale creamy yellow larvae at once burrow under the skin on hatching ; here they form a kind of blister, beneath which they hibernate ; in some, quite a fair-sized chamber was formed. In spring, the little caterpillars commence eating again, gradually enlarging the damage : the result is, the twig dies. When full-fed, namely at the end of April, the larva reaches about 6 mm., is dull grey to greyish-brown, and a dark line on the posterior part of the back ; the head is dark, as are also the true legs.

Pupation takes place in the shoot, and in from two to four weeks the moth emerges. The only preventive of excessive damage seems to be cutting off the diseased shoots as soon as they are noticed in the spring, anyway before the beginning of May.

Gillanders records it also from Northumberland in his recent " Forest Entomology."

The Cockchafer (*Melolontha vulgaris Fab.*).

Adult and larval Cockchafers (*Melolontha vulgaris*) were sent in March, from Cirencester, where they were doing much damage in the nurseries on Lord Bathurst's estate. The trees attacked were larch, the roots being eaten all to bits, and beech were attacked in a similar manner. The ground was being double-trenched as a means of checking them.

This is a well-known forest pest, being especially harmful in nurseries and to freshly planted trees.

Pine Chermes (*Chermes pini* Koch).

Several inquiries have been received concerning this *Chermes*. One from Bristol Museum, a shoot of Scots Pine sent being covered with this aphis.

Austrian pines are also attacked by the same species. It can easily be told by the white cottony masses covering the young shoots ; the shoots then become bent and deformed. The aphis lives under the cottony covering, and may be found as early as April, but most in May.

Specimens received on June 20th were covered with dull yellowish stalked eggs, and these hatched in a fortnight, the young spreading over the trees.

On old trees it does not do any great harm, but where nursery stock is attacked, the young plants are ruined.

The Felted Beech Coccus (*Cryptococcus fagi* Bar.).

This pest continues to increase. It has been reported as causing much harm at Burnham Beeches, and also at Redhill. From the latter locality, Mr. Wm. Rose wrote in November that some trees were badly infested in a plantation there. One tree died last year, another this year, had the whole of the stem on the north side covered with the Coccus standing out from the bark for half-an-inch.

From Cirencester a supposed case of attack by *C. fagi* was reported of considerable interest, for it proved to be a dense incrustation of a white mealy lichen, looking almost exactly like the mealy coating produced by the Felted Beech Coccus. The specimens were sent because it occurred on lime trees in quantity on Lord

Bathurst's estate. The Beech Coccus occurs there, but Mr. Davies informs me that only about one per cent. of the trees are affected, and so far have not succumbed in any appreciable number. There is about 2,600 acres of woodland mostly composed of a mixture of beech and larch, and thus the presence of this pest is a very serious one.

Writing from Combe Bank, Sevenoaks, concerning this coccid in that neighbourhood, Mr. C. Day said the soil is not favourable to the growth of the beech, as there is little or no lime in it, and wondered if it is a fact that the localities where the disease appeared so far are unsuitable to the growth of the tree. This is not so, for in some districts where the beech flourishes best, as at Burnham and in the Chiltern Hills, the attack is very serious.

Red Spider on Lime Trees (*Tetranychus tiliarum* Mull.).

Enormous numbers of this acarid were sent from Ramsgate, on the 25th of September, with the following note,—" The enclosed insects were found at the foot of one of the trees in the South Eastern Road ; the stem of the tree is at places covered with a very fine glistening web, so fine that I cannot collect any, at places up the trunk of the lime tree are patches of these insects, but many fall and are massed on the ground around the stem."

This species is also said to have attacked beans, melons and cucumbers in France in 1874, but probably *T. cucumeris* Boisd, was the real culprit.

The mite is dull yellowish with a faint orange tinge in some specimens. Murray says they chiefly occur on the under side of the leaves which they cover with webbing.

ANIMALS INJURIOUS TO MAN'S FURNITURE, BUILDINGS, AND STORES.

Beetle Larvae (*Nacerdes melanura* Sch.) **Destroying Woodwork.**

The larvae of this beetle feed normally in woodwork on the coast.

An interesting attack on the woodwork in greenhouses was reported from Wisbech, in March.

Messrs. R. H. Bath, Ltd., of the Floral Farms, wrote, sending "specimens of an insect and grub which has infested one of our greenhouse benches. The grubs have bored the wood to such an extent that the benches have all fallen to pieces. Just now the insects are hatching out by hundreds. It is a thing that has not happened with us before."

The beetles proved to be *Nacerdes melanura* (Schmidt).

The beetle varies from 7 to 12 mm. according to Canon Fowler, but those that I have bred from the material sent from Wisbech varied from 10 to 14 mm., a single specimen only being smaller than 10 mm. out of great numbers examined. The beetle is of a reddish-testaceous colour varying to ochreous, with the apex of the elytra black; there are black spots on each side of the thorax in the male, but not in the female; the elytra are dull and parallel and clothed with short fine yellow pubescence, almost golden when first hatched; the legs are pale with black femora; the abdomen is black and also the venter of the thorax. The beetles are extremely active and breed freely in captivity. They deposit large masses of eggs, which are pearly white and very elongate oval in form and delicate in structure.

The larvae formed long straight galleries in the woodwork of the glasshouses some four inches long. Over 100 were found in a piece of wood sent, six inches square, the whole substance being honeycombed by them.

The colour is dull creamy white, and the length when mature, from one-half to five-eighths of an inch, narrowed behind with rather deeply constricted segments; the head and legs are horny and the legs are comparatively long; the head is large but is not as broad as the prothorax in any of the specimens examined, such as is described by Schiödte, nor are the next four segments furnished with a hump or knob on the centre of the dorsal surface in any I have seen.

The pupae are pale creamy with widely detached limbs and darker eyes, gradually darkening as the beetles are maturing.

Beetles were hatching out fast when sent, and continued to do so for a week, then more appeared in two months and it is probable that this represents the time of their life cycle.

The larvae are said by Schiödte to live in dead wood, especially oak. Fowler says in old posts and timber on the sea shore and near the mouths of large rivers; sometimes introduced further inland with timber.

The localities given for it are Surrey Canal and Peckham (probably introduced with timber); Harwich; Dovercourt; Walton-on-Naze; Chatham; Sheerness; Gravesend; Southend; Deal; Dover; Folkestone; Hastings; Portsmouth; Southampton (about rotten railway sleepers); Isle of Wight; Devonshire; Plymouth, etc.; banks of the Humber and Severn; Borth, Wales, Bridlington jetty; Manchester; Northumberland and Durham district, Sunderland and on the wing at South Shields; Ireland, Glas Nevin Gardens, Dublin.

There is no doubt it was imported to Wisbech in timber.

Furniture Beetles.

Information was sought from the Apothecaries' Hall, Blackfriars, concerning beetles damaging furniture.

The two chief species are *Anobium domesticum* and *Xestobium tessellatum*—the so-called Death Watch Beetle, whose larvae tunnel into all kinds of wood in houses and out of doors, as well as into furniture. The former is more generally found in furniture, the latter is the larger and the more destructive. Both are long lived in the larval stage, three years being passed in this condition.

The most successful way of keeping them from renewing their attacks on furniture seems to be painting with a solution of corrosive sublimate. Paraffin oil rubbed well into the attacked parts will destroy many of them in the wood.

ANIMALS CAUSING ANNOYANCE TO MAN.

Mosquitoes (*Culicidae*).

Two inquiries have been made concerning Mosquitoes in Britain and how to get rid of them. One came from the Royal Albert Memorial Museum, Exeter, from Mr. F. R. Rowley; the species being *Theobaldia annulata* Meigen, and *Culex pipiens* Linnaeus.

The former species was also inquired after by Mr. Shipley, who sent a specimen taken indoors, in January.

T. annulata is a very vicious biter and often causes nasty sores. It has been dealt with in my Report for 1904-1905, pp. 111 to 113.

They breed in rain water barrels and small pools. *Culex pipiens* in cisterns and small collections of water, even in empty jars and pots.

Where these flies are an annoyance the barrels, cisterns, etc., should be frequently emptied. Cellars, privies, etc., where the mosquitoes are known to hibernate should be fumigated with pyrethrum. Large pools should be treated with paraffin.

REPORT

FROM THE

ANALYTICAL LABORATORIES.

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SIXTH REPORT

FROM THE

ANALYTICAL LABORATORY,

BY

F. V. Darbishire, B.A., Ph.D. ;

C. T. Gimingham, A.I.C.;

W. Goodwin, B.Sc., Ph.D.

In this report the practice of former years will be continued, and those substances of agricultural importance which have come under notice since the publication of the last report, will be commented upon. Inclusive of milks, the number of samples of various materials sent to the laboratory for analysis, has exceeded 350, and there have also been a considerable number of visits paid by members of the analytical staff to farmers where special inquiry has been thought necessary.

MANURES.

POTASH MANURES.

Since the potash deposits at Stassfurt, in Germany, have been worked, they have supplied practically all the potash manures used in the various countries of the world. The only other sources are wood ashes, muriate of potash from the south of France got by evaporating sea-water, nitrate of potash from India (only very little of which is used as manure), and some carbonate of potash from beet-sugar factories. A couple of samples of wood ashes which were sent in, were found to contain

Ref. No.	Water.	Insoluble Matter.	Potash.
433 *a*	6.31	30.99	6.37
433 *b*	0.28	11.40	9.49

The first sample was obtained from a brick kiln where wood was used, and contained a lot of brick earth ; the second came from a bakery, where the ovens were heated by shavings and wood. Wood ashes serve very well as a potash manure, but the quantities to be obtained are small. Ordinary wood ashes contain 7 to 10 per cent. of potash, and 1 to 3 per cent. of phosphoric acid, and they are a material well worth preserving for use as manure. It is, however, only in exceptional cases that a sufficient quantity is obtained to make it possible to sell them.

KAINIT

is one of the best known of potash manures, and is used in large quantities in this country. It contains on an average 12 per cent. of potash, in some cases more.

Below are the figures obtained for three kainits sent in to us :—

Ref. No.	Potash.	Equivalent to Sulphate of Potash.
436	14.68	27.17
350 *a*	22.5	41.6
350 *b*	23.6	43.6

Without doubt the two last samples had been described wrongly by the seller, or some other mistake had occurred, for they contained almost double the amount of potash usually found in kainit ; in fact, they approximate in composition to sulphate of potash, which contains 48 per cent. potash.

The different potash manures are all imported from the district near Stassfurt, close to the Harz Mountains. These great deposits of potash salts were discovered about the year 1840, when borings were being made to obtain rock salt. It was found that overlying the salt was a layer of minerals containing potash and magnesia, but these were considered valueless and thrown on one side until their use as a manure was discovered. The presence of these large potash deposits is supposed to be due to the evaporation of an inland sea, which existed in that part of the world many thousand years ago. The climate at that time being much hotter than it is now, the water quickly evaporated, and the salts crystallised out and sank to the bottom. This continued, until finally only solid salts remained, and these were covered by an impervious layer of clay, which has preserved them. Common salt being less soluble than the potash salts was deposited first, so in boring for it the potash beds had to be traversed.

These crude potash salts are composed chiefly of carnallite, a mineral containing chloride of potash and chloride of magnesia, from which the concentrated manures are made. In the preparation of muriate of potash from carnallite, the roughly powdered material is dissolved in a solution of chloride of magnesia, and then allowed to cool ; the muriate crystallises out, and is then washed with cold water to purify it. The product obtained in this way contains about 50 per cent. of potash (K_2O), and is the richest manure of this class.

Muriate of potash is not always the most suitable potash manure to employ in spite of its richness, and comparatively low price, for with potatoes, etc., the quality of the crop is apt to suffer.

Kainit, which contains sulphate of potash together with sulphate and chloride of magnesia, is so intermixed with rock salt that the purification is very difficult. On this account it is usually sold with the salt it contains (30 to 40 per cent.), and the potash averages 12 per cent.

When kainit is used as a manure, it should be put on the land early, to allow the salt and other impurities to be washed into the subsoil ; otherwise the crop may be damaged. It is very useful for cereals, mangel, grass, etc., but not so good for potatoes as sulphate of potash.

Sulphate of potash is a purified material made from kainit and contains about 48 per cent. of potash. At the Woburn Experimental Station is was shown that 1 cwt. of sulphate of potash on potatoes gave better results than 4 cwt. of kainit which contains the same amount of potash. The syndicate which owns the potash mines at Stassfurt also manufactures other manures by mixing the various salts, so as to obtain a certain percentage of potash. Two of these mixtures known as 20 per cent and 30 per cent. potash manures are on the market, and the latter is largely used in some districts, and preferred both on account of the results it gives and because at the price at which it is offered the unit value of potash is usually lower than in the sulphate.

NITROGENOUS MANURES.

NITRATE OF LIME.

Two samples of this comparatively new product, nitrate of lime, or as it is sometimes called Norwegian saltpetre, were sent in; one of them had absorbed so much water through being imperfectly packed that the analysis would not be reliable. The other was found to contain

Ref. No.	Nitrogen.	Equivalent to Calcium Nitrate.	Lime.
359	13.0	74.47	27.45

This manure is undoubtedly destined to play a very important part as a nitrogenous manure in the future. It contains slightly less nitrogen (13 per cent.) than nitrate of soda (15 per cent.), and the nitrogen in both is in a form ready to be taken up at once by the plant.

The question of what manure shall take the place of nitrate of soda when the present deposits in Chili are exhausted, has been frequently discussed by famous scientists, and the outlook a few years ago was not encouraging. The world's annual consumption of nitrate of soda is some one-and-a-half million tons, and it has been calculated that at this rate the present supplies can only last some thirty years ; according to some, not even as long as that. Of course, new deposits may be discovered, but it is unlikely that they will equal those which have been so far worked with such profitable results. Even though the gloomy prophecy that in some twenty-five years we shall be faced by famine as a result of the exhaustion of the Chili saltpetre beds, may not be realised, it is certain that as the supply becomes less, the price will rise, for the mines are in the hands of a syndicate which carefully regulates the prices according to the supply. Other competing nitrogenous manures will tend to check this upward rise in price, and it is therefore little wonder that any such materials are welcomed by those who live in an old country and have to depend so largely upon artificial manures to raise their crops.

Up to the present time, ammonium sulphate has been the only serious rival to nitrate of soda as a means of supplying a quickly available dose of nitrogen, but the amount of sulphate manufactured will not suffice for all demands if the nitrate beds become exhausted. The nitrogen, which goes to make the ammonium sulphate, comes from below the ground—from coal principally, which when burnt in a gas works or blast furnace, gives up its 1 per cent. or so of nitrogen to form ammonia. This is then made into the sulphate.

Nitrate of lime is manufactured in quite a different manner, and from the nitrogen above the ground and not below. In the atmosphere we have an almost inexhaustible supply of nitrogen, but except in a small experimental way, it has never previously been used for the preparation of nitrates. That it is possible to get the nitrogen and oxygen of the atmosphere to combine was proved more than a hundred years ago, by passing an electric spark through a vessel containing these two gases. Without doubt, too, lightning also causes the same change, and much of the nitric acid in rain water is formed in this way.

That we have in the air a supply of nitrogen sufficient for all needs is realised when we find that it is calculated that on each seven acres of the earth's surface there are 237,000 tons of nitrogen, equal to the one-and-a-half million tons of nitrate of soda used annually.

The question then was how to get the nitrogen in the air to combine with the oxygen so that it could be used as a manure.

As regards the apparatus and machinery, enough will be said if we mention that the purified air is forced through a chamber in which a high pressure electric arc is working. In order to get as much air in contact with the arc as possible the latter is moved rapidly to and fro by means of a powerful magnet. Under the influence of this very high temperature, some of the oxygen and nitrogen combine and the gases are then passed into towers down which water is trickling, so that the nitric acid and other nitrogen compounds are dissolved out. All that is then necessary is to add limestone to the liquid from the washing towers and Norwegian saltpetre is obtained. Those who wish for further particulars regarding this subject will find details of this interesting and extremely valuable process in various scientific publications.

It remains only to be said that the success of this material depends entirely upon a cheap supply of electricity, and this, of course, can only be obtained by water power. At the Niagara Falls, at Notodden in Norway, and in the North of Italy, works have been erected where the above and similar processes are being tried, and the manufactured material is sent out, so far chiefly for experimental purposes, to compete with nitrate of soda and sulphate of ammonia.

Naturally, such a material was quickly subjected to actual tests to find its value as a manure, and it can be said that it has come out of the trial extremely well, being on an average proportionately equal to the nitrate of soda, and generally superior to ammonia sulphate. The disadvantage it possesses of rapidly taking up moisture from the air is being removed by one or two methods, and it is hoped to get a substance as easily handled as the rival nitrate of soda.

CALCIUM CYANAMIDE.

Another nitrogenous manure which is also manufactured chemically from the nitrogen of the atmosphere is calcium cyanamide or lime nitrogen. The principle of its manufacture, which was begun a few years before that of nitrate of lime, is entirely different.

Nitrogen gas obtained from the air is made to pass over heated carbide of calcium (the material used for making acetylene gas for lighting houses, and for bicycle lamps, etc.), and calcium cyanamide is obtained.

In the manufacture of the carbide, an electric furnace has to be used, so this process, like the one for nitrate of lime, is essentially electrical, and can only be carried on where electric power is cheap.

When the cyanamide is brought in contact with water, it decomposes, giving ammonia and lime, and the same change takes place in the soil. If the cyanamide is covered by a layer of earth so that the ammonia cannot escape, we have a supply of nitrogenous material easily acted upon by the bacteria of the soil and made into nitrates.

As a fertiliser, cyanamide has been extensively tested in this and other countries, and on all kinds of crops. The results have shown that under certain conditions it is quite the equal of sulphate of ammonia, but usually falls below nitrate of soda, weight for weight of the nitrogen it contains.

The material is a fine powder, similar in appearance to basic slag, and it is advisable to mix it with earth or superphosphate when sowing, otherwise considerable quantities may be blown away. It cannot either be used in the same way as nitrate of soda or nitrate of lime, as a top dressing, and requires to be some ten to fourteen days in the ground before the seed is sown.

Calcium cyanamide contains about 20 per cent. nitrogen, and is also sold under the name of Nitrolim.

SHODDY.

Shoddy and other similar organic manures are largely used in hop gardens, and also by some market gardeners. They are valuable as adding a supply of nitrogen to the soil, which will become slowly available for the plant. It is the wool in the shoddy that makes it valuable ; cotton contains no nitrogen, and is therefore valueless. These manures are priced upon the percentages of nitrogen which they contain, and it is sometimes difficult to account for the variations in the unit value of nitrogen. Shoddy which contains oil or grease is less valuable, for it only slowly undergoes decomposition in the soil.

Ref. No.	Description.	Nitrogen.	Equivalent to Ammonia.
394	Shoddy - - - -	4.4	5.35
383	Shoddy - - - -	6.31	
342	Shoddy - - - -	4.0	4.86
328	Shoddy - - - -	5.5	6.7
247	Shoddy - - - -	3.99	4.84
338	Fur and skin waste -	10.05	12.20
322	Sheep tags - - -	3.0	3.6
277	Wool waste - - -	7.99	9.7

The average percentage of nitrogen in the samples of shoddy we have received is 4.84, which is below that of the past few years. The fur and skin waste is a valuable nitrogenous material, as is also the wool waste.

FISH GUANO.

A good many of the imported fish guanos reach the consumer in an unsatisfactory state owing to damage in transit. One sample which was found to contain

Ref. No.	Nitrogen.	Equivalent to Ammonia.	Phosphoric Acid.	Equivalent to Tricalcic Phosphate.
232	6.02	7.3	6.25	

was in such a bad condition, being in big wet lumps, that it would have been most difficult to sow satisfactorily.

Fish guano still continues to be used as a nitrogenous and phosphatic manure, particularly on light soils, where it does very well.

A good deal of fish refuse of a better class is now made into fish feeding cake or meal, and most satisfactory results are reported from its use. In spite of the smell, cattle and pigs eat it readily, and it also makes a good poultry food when mixed with pieces of boiled potato. It has not been found that the smell of the fish meal has any bad effect upon the flavour of the milk or butter, nor upon the beef or pork where fattening stock have been fed with it.

The chemical composition of fish feeding meal closely resembles that of fish guano, but usually contains more protein and fat, both of which are in a highly digestible form.

Wolff and Lehmann analysed two average samples and found

	Water.	Crude Protein.	Crude Fat.
Fish Meal -	12.8	52.4	2.2
Fish Guano -	12.6	49.0	1.8

PHOSPHATIC MANURES.

BASIC SLAG.

Only two samples were received this year, and they had the following analysis :—

Ref. No.	Phosphoric Acid.	Equivalent to Tricalcic Phosphate.	Fineness.
358 *a*	19.61	42.81	95.8
358 *b*	19.58	42.76	96.7

The solubility in 2 per cent. citric acid (Wagner's method) is not as a rule determined unless it is specially asked for.

From the above it is seen that the percentage of phosphoric acid, and the fineness are both satisfactory. The phosphate in both cases is above the average of that found in the samples of the past few years. The fineness, which is measured by sifting through a sieve containing 100 meshes to the linear inch, is an important property of basic slag, for it is only slowly available, and when put into the soil in a coarse condition, only gives poor results, The grinding machinery has been a good deal perfected in the last few years, with the result that slags are usually now put upon the market in a fine-grained form.

FEEDING STUFFS.

LINSEED CAKES.

With one exception these were found satisfactory.

Ref. No.	Oil.	Protein.	Nitrogen.	Fibre.	Nitrogen free extract	Mineral Matter.	Sand.	Water.
420	9.05	26.42	4.22	7.52	35.61	7.92	2.25	13.5
414	9.56	29.82	4.77	7.45	35.34	7.55	1.76	10.28
343	10.42	28.74	4.60	8.59	32.52	6.17	1.12	13.56
284	11.63	34.38	5.49	6.87	30.15	2.91	0.31	14.04

The amount of sand in No. 420 is more than it should be, and the cake altogether was not a very good sample.

All the cakes were " old process " ones in the making of which the crushed linseed after heating to a temperature of about 165° F., is pressed between cloths in a hydraulic or electric press, and the oil squeezed out. Cakes made in this way are to be preferred to those made by what is known as the " new process," where the crushed seed is extracted by means of some solvent such as naphtha. After the extraction, steam is blown through the linseed to get rid of the naphtha, and the residue is pressed into cakes. These are usually much harder, and contain less oil than do the old process cakes. The colour is often darker, and it has been proved that in many cases the heating, which the linseed has undergone when steam was blown into it, has rendered the proteids less digestible. The old process cakes, especially if of English manufacture, are to be preferred, for they are softer and contain more oil than do the American made new process cakes.

MEALS.

Most of the samples of feeding meals sent to us for analysis do not call for comment, but we have received two which are interesting.

The first of these (Ref. No. 345) was sent in with the request that we would first ascertain its value as a feeding stuff, and if that proved small, also determine its value as a manure. The following is the complete analysis :—

As a Feeding Stuff.

Oil - - - - -	1.99 per cent
Nitrogen - - - - -	1.98 per cent
Protein - - - - -	12.38 per cent
Mineral Matter - - - -	31.20 per cent
Containing sand - - - -	20.6 per cent
Moisture - - - - -	10.69 per cent

As a Manure.

Nitrogen - - - - -	1.98 per cent
Equivalent to Ammonia - -	2.41 per cent
Phosphoric Acid - - - -	0.75 per cent
Equivalent to Tricalcic Phosphate -	1.64 per cent

The extraordinarily large proportion of sand of course makes this material utterly unsuitable for feeding to stock : moreover, the actual amount of protein and oil is very low. We obtained a larger sample of the bulk, and it was found to contain scraps of paper, pieces of string and much dust and grit : it had, in fact, the appearance of sweepings of some sort. The manurial value was also exceedingly small. The small amount of nitrogen and phosphoric acid which it contains would not even pay for transport of a material of which more than 20 per cent. was sand. And 82s. 6d. per ton was the price asked !

Sample No. 317—a feeding meal—gave the following analysis:—

Water.	Oil.	Protein.	Fibre.	Sand.
2.23	4.75	6.93	34.61	3.03

The farmer who sent this sample had recently lost several young pigs very suddenly. The cause of death was at first put down as swine-fever, but this was found to be incorrect. Death of several animals had occurred on two different occasions immediately after feeding them somewhat liberally with this meal. There was nothing in the analysis to suggest that the material was in any way dangerous to stock, but it was found that the sample contained a lot of cotton-seed meal.

Cotton seed meal is known to be a very unsuitable food for young stock of any kind, particularly calves and pigs, many cases are on record where it has proved fatal, and it is practically certain that in this case, death was attributable to feeding with this substance. On discontinuing its use, the deaths ceased.

FLAKED MAIZE AND UVECO.

These food stuffs which are very similar in composition on analysis, gave :—

	Ref. No.	Water.	Oil.	Protein.	Nitrogen free extract	Fibre.	Ash.
Flaked Maize	386	13.5	2.46	10.7	70.63	1.6	1.11
Uveco - -	396	12.84	1.27	9.54	74.4	1.21	0.74

Both these materials are prepared by passing maize over heated rollers, and the process results in crushing and cooking the grain so that it is rendered more easily digestible. The price asked for the flaked maize was £8 per ton which, considering the small amount of oil and protein which it contains, is high.

Good results have been obtained with these foods with sheep, cattle and horses, but some nitrogenous food ought to be given at the same time.

SAGO MEAL.

Ref. No.	Water.	Oil.	Protein.	Nitrogen free extract.	Fibre.	Ash.
388	18.38	0.75	1.31	79.14	0.03	0.39

This is a very starchy food, too low in oil and protein to be fed unless some concentrated cake or meal are included in the ration.

Compared with Middlings, an average analysis of which is

	12.1	4.0	15.6	60.4	4.6	3.3

the sago flour has distinctly less feeding value.

LIME.

A sample of a substance known as paring dust manure was one of the few new materials that have come under notice.

The analysis showed it to contain

Ref. No.	Carbonate of Lime.	Nitrogen.
329	74.7	0.065

It resembles in composition some residues from tanneries known as "lime grounds," but these have always contained about 1 per cent. of nitrogen. This material was offered as a general fertiliser, and a somewhat high price was asked for it, but any value that it had would be confined to the carbonate of lime which it contains, and for liming purposes it might be useful.

A poor sample of agricultural lime gave on analysis

Ref. No.	Lime.	Undecomposed Chalk.
261	72.63	17.43

White agricultural lime contains about 85.2 per cent of lime, of which 5 to 6 per cent. is undecomposed chalk.

POISONING CASES.

The stomach of a dog which had died suddenly with all the symptoms of strychinine poisoning was analysed, and large quantities of the poison were found to be present.

In another case several in-lamb ewes had died, and it was thought that this was due to contamination of the drinking water either by sewage or by some disinfectant put into the drain to counteract the smell of the sewage. The analysis of the water showed it to be quite unsuitable for stock of any description, the sample containing a large amount of organic matter. No trace of the disinfectant material, which was a semi-solid block resembling soft soap and smelling strongly of terebinth or similar oil, could be found in the water. It is well known that pregnant animals are more susceptible in that condition to impurities of food or drink. Unfortunately the carcases had been destroyed before we were communicated with, so that an examination could not be made.

It cannot be too strongly urged upon those who wish advice on matters of this description that they should communicate with the College at once, so that a competent person can be sent to inquire into all the particulars of the case. An isolated chemical analysis often quite fails to throw light upon a matter which would otherwise not be difficult if all the facts were known.

WATERS.

As have been mentioned in previous reports, the chief trouble with regard to the supplies of drinking water in Kent and some parts of Surrey is that they are so liable to contain too large a proportion of solid matter in solution. When the amount of total solids determined by analysis exceeds 50 parts per 100,000, a water cannot be considered suitable for drinking purposes, although by long use, people can become accustomed to a high percentage of solids. It will be seen from the appended table that all the samples of water sent in to us for analysis during the past year exceeded with one exception (No. 241) the above limit for the total solids, and on that account they were condemned by us as being unsuitable for drinking purposes, particularly for children. Samples 360 and 424 were intended for use at schools, but with as much as 140 parts per 100,000 of solid matter in solution, they were certainly quite unfit. The two samples 323 and 352 were from sources quite near together, and gave similar figures on analysis. In cases like these, in which the total solids are only slightly above the limit, it is probable that they would prove safe enough for drinking purposes, although for delicate children they certainly had better be softer.

The hardness of a water is also an important question when it is used for domestic purposes, for in washing much more soap has to be used to produce a lather, and in cooking, vegetables are seldom as good as when boiled in soft water, nor is it possible to make good tea with a hard water. As a rule, though not always, a water which has a high solid content, will also be hard, and thus will be uneconomical both for the reasons given above, and for use in technical processes such as making up hop washes. Nos. 287, 360 and 424 show very excessive hardness.

On the other hand, only one of the samples analysed (287) could be considered objectionable, because of contamination with organic matter. Besides those mentioned in the table, however, one water was sent in which, without being completely analysed was found to be utterly unfit for drinking, and appeared to be considerably contaminated with sewage of some kind. It showed the presence of quantities of nitrites and contained a good deal of suspended matter, which imparted a greenish colour to the water. This came from a newly sunk well, but there was no obvious source of contamination in the immediate vicinity. (See Table, page 202).

A note on the significance of each of the constituents usually determined in a drinking water may be useful.

Total Solids. The importance of the amount of total solids present has been discussed. Their character depends principally upon the nature of the soil through which the water has percolated.

Free Ammonia. The presence of ammonia either in the free state or as ammonium salts indicates *recent* sewage contamination, It is formed on the decomposition of organic nitrogenous matter, and is pretty certainly always of animal origin.

Albuminoid ammonia is also an indication of organic matter.

PARTS PER 100,000.

Ref. No.	Total Solids.	Nitrogen as free Ammonia.	Nitrogen as Albuminoid Ammonia.	Nitrogen as Nitrite.	Nitrogen as Nitrate.	Oxygen absorbed.	Chlorine.	Hardness.
241	35.0	.0054	.0087	nil	.0865	.034	2.3	25.5
287	95.16	.089	.134	trace	.80	.142	13.5	52.85
311	144.5	.0033	.0087	nil	.107	.052	24.5	31.96
323	58.25	.0054	.012	nil	1.145	.013	4.6	29.8
352	51.9	.0026	.0081	nil	.74	.012	3.3	27.4
339	121.0	.0053	.0081	nil	.576	.027	27.8	36.95
360	138.4	.0046	.0138	trace	2.06	.081	13.6	63.05
418	149.5	.0092	.0269	nil	2.198	.061	9.0	30.4
424	141.8	.0043	.0089	nil	.827	.0337	4.2	74.57
	7.8	nil	.002	nil	nil	.05	.8	2.3

For comparison, an analysis of a fairly typical pure upland surface water is given at the foot of the table; the low total solids and the low degree of hardness are in sharp contast to the figures for all the samples received by us.

Nitrites when found in a water in any quantity, are a sufficiently certain sign of recent sewage contamination to condemn it at once. The nitrite in itself is not dangerous, but it is one of the first oxidation products of organic nitrogen.

Nitrates are of similar significance to nitrites. They do not, however, indicate such recent contamination, for nitrates are the final product of the oxidation of nitrogenous organic matter. So long as the conditions are such that all organic nitrogen is rapidly oxidised to nitrates, there is no danger, but should this oxidation be hindered from any cause, organic matter of a dangerous nature may begin to accumulate in the water.

Oxygen consumed is a measure of the amount of oxygen required to oxidise any organic impurities, and so gives comparative figures for the amount of organic matter present.

Chlorine may get into a water from the sea, for it is usually present as sodium chloride. An excessive amount, however, usually implies sewage contamination, though there are cases where this does not hold. The water in Jersey, for example, contains quantities of chlorine, but it is present as magnesium chloride and the water is entirely wholesome.

Hardness. The hardness of a water is of paramount importance when it is to be used for technical purposes. For use in boilers a very hard water is particularly undesirable, owing to the scale which collects : also a hard water requires more soap than a soft one to produce a lather and consequently is inconvenient when required for washing purposes.

SOFT SOAP.

In examining a sample of soft soap as to its value for making up hop washes, there is only one factor which is really of great importance, that is to say, the lathering power. It is essential to adopt some standard by which soaps may be compared from this point of view, and it has been found convenient to determine in each case the number of pounds of soap required to produce a lather with 100 gallons of the College water. The hardness remains very constant and is equal to twenty parts of lime per 100,000. The average amount of a good high class soap required to produce a lather with 100 gallons of College water is 3½-4 lbs. The samples sent in to us this year have been of uniformly good quality, the lathering power varying between 3.7 and 4.6 lbs. per 100 gallons. There was one exception however which is worth noticing, for the sample instead of having the usual more or less translucent appearance of ordinary soft soaps, was lumpy and quite crystalline. On analysis its lathering power was found to be only about one-third of that of an ordinary good quality soap, *i.e.*, it required 12.4 lbs. per 100 gallons to produce the lather. Further, it contained 36.5 per cent. of potassium carbonate, which accounted for the crystalline appearance.

The presence of carbonates in a soap indicates that it has been kept a long time and is deteriorating. The price asked for the bulk of which this was a sample certainly appeared to be cheap, but when the very poor quality of the soap is taken into consideration it was excessive.

As a rule the only other determination we make besides the lathering power is the amount of free alkali present. A small proportion in a soap to be used for washing hops is not harmful, but any excess is likely to cause injury to leaves. In none of the samples examined was there sufficient free alkali to do any damage. The amount varied between 0.44 and 0.06 per cent.

MILKS.

It is gratifying to be able to report that the number of samples of milk analysed at the College has steadily increased since the cheaper rate of 6d. per sample was instituted. This shows that farmers are beginning to realise that a knowledge of the amount of fat in the milk is often very useful, Such a knowledge in fact is practically essential if the value of individual cows is to be determined. Some cows give habitually a milk poor in fat, and the best course with them is to give them a walk—off the farm. A cow giving milk with a normal percentage of fat costs no more to keep than one yielding poor milk.

The value of different food stuffs in the production of milk can be much better judged when the milk is regularly tested and a clearer idea obtained as to the commercial value of the milk and the cost of production. If to this is added the fact that milk sold when it contains less than 3 per cent. of butter fat renders the seller liable to prosecution and a stiff fine, it will be clear that the testing of milk is a very important matter. It is hoped that the number of samples to be tested will still further increase, not on account of the trifling income which they bring, but because of the benefit which is certain to accrue to the milk producer if he makes use of the results. What it is possible to do in this direction was clearly shown a few months ago by a farmer in this district. He discovered that his morning's milk was always below the standard, and as his cows were being fed plentifully he was puzzled to know what the cause was. Analyses made of the afternoon's milk showed them to be rich in fat, so that neither the cows nor the feeding were to blame. When, following our advice, the hours of milking were changed there was at once an improvement, and after a readjustment of the ration it was found that the morning's milk with few exceptions was above the standard. Only in one case was it necessary to get rid of a cow, all the others proving quite satisfactory under the new conditions. Instead then of receiving from this farmer samples of milk, half of which were not up to the legal standard, it is now exceptional to find any below.

It is of course a well known fact that the longer the interval between successive milkings the poorer does the milk become in fat. The results of experiments carried out by Crowther at Leeds and reported in the Journal of the Highland and Agricultural Society for 1903 clearly show this.

	Intervals of Milking.	Percentage of Fat.	
		Morning.	Afternoon.
1st period	15 hours at night, 9 hours in day	2.86	4.26
2nd ,,	12½ ,, ,, 11½ ,, ,,	3.18	3.80
3rd ,,	15 ,, ,, 9 ,, ,,	2.94	4.40

The total quantity of fat in the day's milk does not alter much, but there is a marked variation where the interval between successive milkings is unequal.

A further proof of the truth of this statement is given in the case of a Kent farmer who wished his herd tested systematically. This was done for a period of five weeks, the milk being sampled at the farm by one of our own staff and then sent to the laboratory to be analysed. The herd was a mixed one, and in the case of 10 cows the following figures were obtained :—

Cow	1	2	3	4	5	6	7	8	9	10	Aver.
Morn.	3.15	2.60	2.72	3.10	2.22	3.04	2.62	2.50	3.22	5.14	2.87
Even.	4.27	3.37	3.60	3.21	3.82	4.05	3.39	4.02	3.66	6.04	3.76

The cows were milked at 5.45 a.m. and 3.30 p.m., so that the intervals were fourteen and ten hours respectively. The ration which they got was a good one, and the sampling having been done by a competent person, no mistake could have occurred in that way. It will be seen then, from the above figures, that if the morning's milk had been sampled by an inspector, the seller would have been liable to prosecution, although for those five weeks there was absolute proof that the milk was in the condition in which it came from the cow, but still below the standard.

With the advantages now offered for the testing of milk, there ought to be fewer cases of legal proceedings, for in the majority of instances, there has been no attempt at adulteration. Too long a period between milking, or an unsuitable ration are the most usual causes, and these could often be easily remedied.

Of the milk sent to us during the past year, 27 per cent. were below the legal standard for butter fat, and this agrees well with the percentage of the past two years, viz., 26 and 25.6. Unfortunately, it is not generally stated if the sample is morning's milk or evening's, and it would be very helpful if a few particulars as to the times of milking, breed of cow, etc., were given. This information would serve a most useful purpose in enabling statistics with regard to the milk produced in Kent and Surrey to be compiled. Isolated cases are not of much value where milk is concerned, for cows differ so much individually that it is only the average results of a great many figures that can be relied upon.

It is hoped that those in the habit of sending milk to be tested will kindly note this.

In many cases, too, it is doubtful if sufficient care is exercised in taking the sample. Milk if left to stand for only a short time separates into layers, and therefore requires to be vigorously mixed before the sample is taken. A small dipper is the most suitable instrument to use in taking a sample from the pail for with it the milk can be well stirred up, and the dipper drawn up from well below the surface.

Where the sample is taken from the churn, a " rouser " made from a circular piece of wood or tin plate, perforated with holes, and fixed to a long handle is the best. With this the contents, of the churn can be thoroughly mixed in a few up and down strokes. and then the sample taken with the dipper in the ordinary way.

How easily cream rises is seen from the following analyses :—

A	3.1	parts butter fat	per	100.
B	2.7	,,	,,	,,
C	3.4	,,	,,	,,

The sample A was taken from a churn as it left the farm to go the round in a town ; B is a sample drawn from the churn by a tap at the bottom twenty-five minutes afterwards ; and C is a sample taken from the upper twelve inches of the churn by means of a dipper.

The samples were sealed up and sent to us, and prove clearly that unless milk is well mixed an average sample cannot be obtained, and further that the shaking in the cart fails to keep the milk properly mixed.

SOILS.

As it is hoped to publish shortly in a separate volume the results of the Soil Survey of Kent and Surrey, no mention will be made in this report of those soils which have been analysed during the time which has elapsed since the previous report.

DETERMINATION OF DIGESTIBILITY OF FEEDING STUFFS.

W. Goodwin, B.Sc., Ph.D.

The amount of food consumed by an animal is not a direct measure of the quantity of nutritive substances actually utilised in the body for the production of heat, energy, body substance or milk. It is only that portion of the food which is digested and so enters into the blood supply that is available for any or all of the above purposes. On this account it is very important when valuing a feeding stuff or making up a ration to know what percentage of the nutrients in the food is digestible. The proportion of the digestible food nutrients to the amount shown by chemical analysis to be present is called the "digestibility coefficient." If, for instance, the digestibility coefficient of protein in linseed cake is said to be eighty-six, it means that in a cake containing 33.5 per cent. protein, 28.8 per cent. would be digestible. The chemical analysis of a food only shows how much protein, carbohydrates, fat, crude fibre, etc., are there without reference to their digestbility. One has only to turn to any of the published tables, which show the percentage of digestible constituents in feeding stuffs, to see how greatly the amounts digested vary in comparison to the total nutrients shown by analysis to be present.

Oat straw, for example, contains :

Crude Protein. Per cent.	Carbohydrate. Per cent.	Crude Fat. Per cent.	Crude Fibre. Per cent.
3.8	35.9	1.6	28.7

and of these the following amounts are digestible :—

Per cent.	Per cent.	Per cent.	Per cent.
1.3	16.5	0.5	20.9

If a ration were based upon the chemical analysis of the straw, without reference to its digestibility, a very serious error would be introduced, for the digestible protein is only one-third of the total, the same proportion also being shown for the crude fat.

Take again the case of a concentrated food, such as decorticated cotton cake, the analysis of which may be taken as :—

	Crude Protein. Per cent.	Carbohydrate. Per cent.	Crude Fat. Per cent.	Crude Fibre. Per cent.
Total ..	48.0	21.6	9.1	6.5
Digestible ..	41.3	14.5	8.6	1.8
Digestibility-coefficient	86	67	94.5	27.7

Here it is seen that the coefficients of digestibility are high, particularly those of the protein and fat, and this is in marked contrast to the case of a coarse fodder such as straw.

In general it may be said that the percentage digestibility of oil cakes and oil cake meals is high, whilst coarse hard foodstuffs are utilised to a much less extent. An example of an almost perfectly digested food is seen in the case of cow's milk :—

	Crude Protein. Per cent.	Carbohydrate. Per cent.	Crude Fat. Per cent.	Crude Fibre. Per cent.
Total ..	3.5	4.6	3.4	—
Digestible ..	3.3	4.6	3.4	—

There are many materials sold for food which show a very good analysis with high percentage of protein and fat, but they often do not possess the value which the analysis indicates. An extreme example may be quoted. The husks of the cocoa bean which are somewhat similar in chemical composition to wheat bran, were found when a digestibility trial was made with them to compare very badly with the bran as the following figures show :—

	Crude Protein. Per cent.	Carbohydrate. Per cent.	Crude Fat. Per cent.	Crude Fibre. Per cent.
Total ..	16.1	46.0	8.2	13.4
Digestible ..	.7	35.4	5.7	4.4
Wheat Bran.				
Total ..	15.5	54.0	4.8	10.2
Digestible ..	12.9	40.5	3.7	2.1

If the value of these two materials were based upon the analysis alone, their respective prices would not differ a great deal, but when it is seen that only .7 of the 16.1 per cent. of protein in the cocoa bean husks is digestible, and that the fat also is not particularly well digested, nobody would think of paying as much for this material as they would for wheat bran.

A knowledge of the digestibility of a food, particularly a new one, is then an important matter for, as the examples quoted above show, the purchase of a foodstuff upon its analysis alone may result in a considerable loss of money. On the other hand, there are feeding stuffs which possess a high degree of digestibility, and these may for some reason, be offered at a price which makes them decidedly cheap, owing to the fact that where the nutrients are well digested the total amount taken up by the body may exceed that yielded by a food with a better chemical analysis, but with a lower coefficient of digestibility. Again, a knowledge of the digestibility of a food coupled with the chemical analysis will often convince a buyer that he is simply paying for the name when he buys some particular food, and that another might well be substituted with profit to himself. It is remarkable, too, how often the smell, appearance, local prejudices, etc., have an influence upon the selection of feeding stuffs. Unfortunately, in this country, pace has not been kept in this branch of agricultural science with Germany, America or Denmark. Most of the tables of digestible constituents of food stuffs are of German origin, and, however excellent they may be, and undoubtedly are, it would be more satisfactory if we in England made similar determinations for ourselves, both on account of the differences in the foods used here, and for the fact that information in a foreign journal does not generally reach our own farmers.

It was in order to ascertain the latest methods employed in this kind of work that the writer visited some of the most important German Agricultural Experiment Stations in the spring of this year. The first station inspected was that of Möckern, near Leipsic, which is the oldest in Germany, having been founded in 1851. It has always taken a very prominent part in work connected with the feeding of animals, and the present Director, Professor Kellner, is one of the greatest living authorities on this subject. Permission to view the station was most readily given by Professor Kellner, and he devoted a good deal of his valuable time to a careful explanation of the analytical methods and apparatus used in digestibility and similar experiments.

The laboratory at Möckern is arranged to carry out, with as little labour as possible, the large amount of routine work which is involved in experiments on the digestion and utilisation of food in the animal body. Everything possible has been done to reduce the time spent in analysis, and to ensure the exactitude which investigations of this kind require. The method of carrying out ordinary digestibility trials, which will be described later, is simple compared to the investigations which are made with the object of following the changes which the food undergoes in the body, before being converted into heat, energy, body tissue, etc. All these complex changes are grouped together and called the metabolism of the food, and as branches we have protein, carbohydrate, fat, etc. metabolism.

For the purpose of studying the metabolism of food, not only has the ration to be analysed and given in carefully weighed quantities, the dung and urine collected without loss, and also analysed, but the gases given off by the animal must be estimated. These gases which come from the lungs, skin and intestine, consist chiefly of carbon dioxide, and marsh gas, and are a measure of the carbon metabolism taking place in the body under the conditions which the animal finds itself, as regards food supply, performance of work, etc. It is only by the collection and analysis of all gaseous products formed during the metabolism of the food, that an exact estimate of the income and expenditure of the body can be arrived at. A description of the complicated apparatus, by which these investigations are rendered possible, can hardly be described here ; but it may be mentioned that the animal under experiment is confined in a chamber into which a stream of pure air is led, and this, on leaving the apparatus, is carefully measured and analysed. This apparatus or respiration chamber as it is called, was invented by Pettenkofer, and bears his name. Germany has four or five of these respiration chambers, America also several, whilst in England there is not a single one. Recently a respiration chamber, designed for experiments with human beings, has been erected at the Sheffield

University, but it seems as though we should have to wait some considerable time before a respiration chamber for animals is provided, either by State or private munificence. The experimental stations in Germany and America are State institutions, with an assured revenue, and so they are able to obtain the money necessary for the purchase and maintenance of these costly pieces of apparatus.

From Möckern, the writer went to Göttingen, to the Agricultural Institute, where the laboratories, feeding stalls, etc., of Professor F. Lehmann are located. This institution is practically a continuation of the famous Weende Experimental Station (Weende is a small village a mile or so from Göttingen) where Henneberg and Stohmann did such a lot of work on the feeding of animals. Göttingen also possesses a respiration chamber, which was formerly used by Henneberg. The additions and improvements to the buildings, which have been carried out by Prof. Lehmann, make this Institute one of the best in Germany.

Along with digestibility trials and experiments on the metabolism of food, numerous feeding tests on bullocks, cows, pigs, etc., are made, so that the information obtained with one or two animals in a purely scientific manner can be tested under conditions which resemble those of actual practice. Here, as at Mockern, one cannot fail to be struck with many ingenious contrivances for rendering the work of analysis less laborious, so that in the course of a year a very large number of feeding stuffs are tested and reported upon for the farmers of the district. It is instructive to learn that full advantage is taken, by practical men, of the facilities offered by the Institution in this respect.

It was of great interest to see in Göttingen the apparatus which Professor Lehmann has designed and erected for the purpose of breaking down straw, so as to render it more digestible. For this purpose straw is heated with a two per cent. solution of caustic soda for six hours, in a boiler, under a pressure of 60 lbs. to the square inch. At the end of this time the straw has become quite soft, and the effect of heating under pressure has been to form organic acids from the straw, which neutralise the caustic soda and destroy the alkaline nature of the contents of the boiler. On cooling, the prepared straw requires no further treatment, but can be fed direct to cattle or sheep, both of which eat it readily.

As regards the digestibility of straw treated in this way, it was found from feeding experiments with sheep that 56 to 60 per cent. of the organic matter was digested. In a sheep fattening trial it was further shown that 1,000 parts of the treated straw and 170 parts of cotton cake meal were equal to 1,400 parts of clover hay. Two milking cows, which were fed with large quantities of the prepared straw for six months, thrived on it, and did not suffer from any digestive disturbance.

Kellner, who also experimented with straw prepared in a slightly different manner, found that his product was about equal in food value to a pure starchy food ; so that the low digestibility coefficient of straw must be attributed to the incrusting materials in the fibre.

It is unfortunate that, up to the present, no simpler method has been discovered whereby straw can be made to serve more economically as food on the farm. A lot of valuable material is, undoubtedly, to be got from the straw, but the difficulties and expense of preparing it in the above-mentioned manner prevent any general use being made of the process. Other methods have been proposed, and tested, but the results have not been so satisfactory as those got by Professor Lehmann.

The next station which the writer visited was at Poppelsdorf-Bonn, where Professor Hagemann has his animal physiology laboratory. The work done by Professor Hagemann is principally of a very scientific description, and deals with subjects rather outside the scope of this article. Mention should, however, be made of the respiration calorimeter which has been built there, and which is a very complex apparatus, designed to serve as a respiration chamber for measuring and analysing the gases coming from the animal body, and also to determine the amount of heat given off by the animal during the experiment. This respirational calorimeter which is on the principle of the Atwater-Rosa calorimeter at Middleton, Conn, U.S.A., is the only one of its kind in Europe, and is a most intricate piece of machinery, which has cost some £10,000 to erect, and bring into working order. A similar calorimeter is being built at Washington D.C. at the expense of the Carnegie Trustees. The skill and labour which are required in conducting investigations with this apparatus can only be realised by those who have seen it, or have a knowledge of this kind of work.

A second type of respiration apparatus is also used in Professor Hagemann's laboratory. This is the Zuntz apparatus, designed to measure and analyse the gases produced in respiration under various conditions. It differs from the Pettenkofer respiration chamber, in being in the shape of a mask, which is fitted to the head of the animal, and so enables the expired gases to be collected and analysed. With this form of apparatus an allowance has to be made for the gases coming from other parts of the body, which have been found by other experiments to average 2 per cent. of the total.

Thanks to the courtesy of Professor Hansen, the writer was permitted to visit the estate of Dickoppshof, near Bonn, where about sixty head of dairy cattle are kept for the purpose of investigations on feeding. These experiments are designed to show the effect that the food has upon the increase of body weight and the yield of milk. Generally one food is compared directly with another, and the cows are divided into groups so as to eliminate individual peculiarities. In this way a lot of valuable practical information is collected, which is published by Professor Hansen, and distributed to those of the province who are interested in the subject. Farmers can also visit the estate when they wish, and the manager, or his assistants, goes round with them, and explains what is being done and what is known on the question into which inquiry is being made.

Another branch of animal husbandry is also studied by Professor Hansen, and that is the relative values of the various breeds of cows. Groups of the best known types are minutely compared, with the object of finding which cattle are the most profitable and useful in that part of the country. The weighing of the rations and of the cattle is regularly and frequently done, and care taken that in the housing and attendance all shall be treated as much alike as possible. In this way the conclusions of an experiment have a great value, and it is this and similar work which can so fitly be carried out at an Experiment Station or an Agricultural College, where more attention can be paid to accuracy and detail than is possible on the farm.

Before going on to describe the methods used in determining the digestibility of a food, the writer would like to express his sincere thanks to Professors Kellner, Lehmann, Hagemann and Hansen for kindly allowing him to visit their respective Institutes, and also for the valuable information and advice which they so unsparingly furnished. Further, also, to Drs. Hauers of Göttingen and Rostafinski of Bonn, for their friendly help.

A determination of the digestibility of the constituents in a food or ration is usually carried out upon one or more sheep, which are kept in small stalls specially built for this purpose. By analysing an average sample of the food which is to be given to the animal, and feeding carefully weighed quantities, it is known how much nutritive matter is consumed. If then the dung is collected without loss and analysed in an exactly similar manner to the food, the difference between the two may be taken to represent the amount of food digested. This assumption is, however, not quite correct, for in the dung there are nitrogenous and fatty substances which come from the bile, digestive juices, walls of the intestine, etc.

Kellner, who investigated the amount of nitrogen due to this cause, found that on an average it was only 4 grams for each 100 grams of nitrogen in the dung, which is negligible.

In conducting a digestibility trial, the food, as has been said, must be exactly weighed out to the animals, and the amount so adjusted that the whole of it is eaten. One or more male sheep are usually chosen, the dung and urine collected separately by means of apparatus specially designed for the purpose. For the dung a rubber lined bag is attached to the posterior parts of the animal, whilst to collect the urine a rubber lined funnel, from which a tube passes to a bottle below the stall, is used. Where the experiment is simply to determine the digestibility of the food the urine is not analysed.

The stall consists of a box some 42 ins. long, 24 ins. wide, and 40 ins. deep, the back of which falls to admit of the entrance of the animal. The stall stands upon legs, with enough space below for the bottle in which the urine is caught. The front part of the stall and the manger are lined with sheet zinc, and a sliding door shuts off the manger when necessary. Water, which is placed in a tin hung on the outside of the stall, can always be obtained by the animal through a hole cut in the side of the stall. The accompanying photograph will serve to give an idea of the stall and harness.

In the case of a ruminant some considerable time elapses before the residues of the previous food are entirely removed from the body, so that before a collection of the dung begins, a preparatory feeding with the material which is under investigation should take place. Where a concentrated food is being tested it is usual to first determine the digestibility of a food, such as hay, then add the other food to this, and determine the digestibility of the whole.

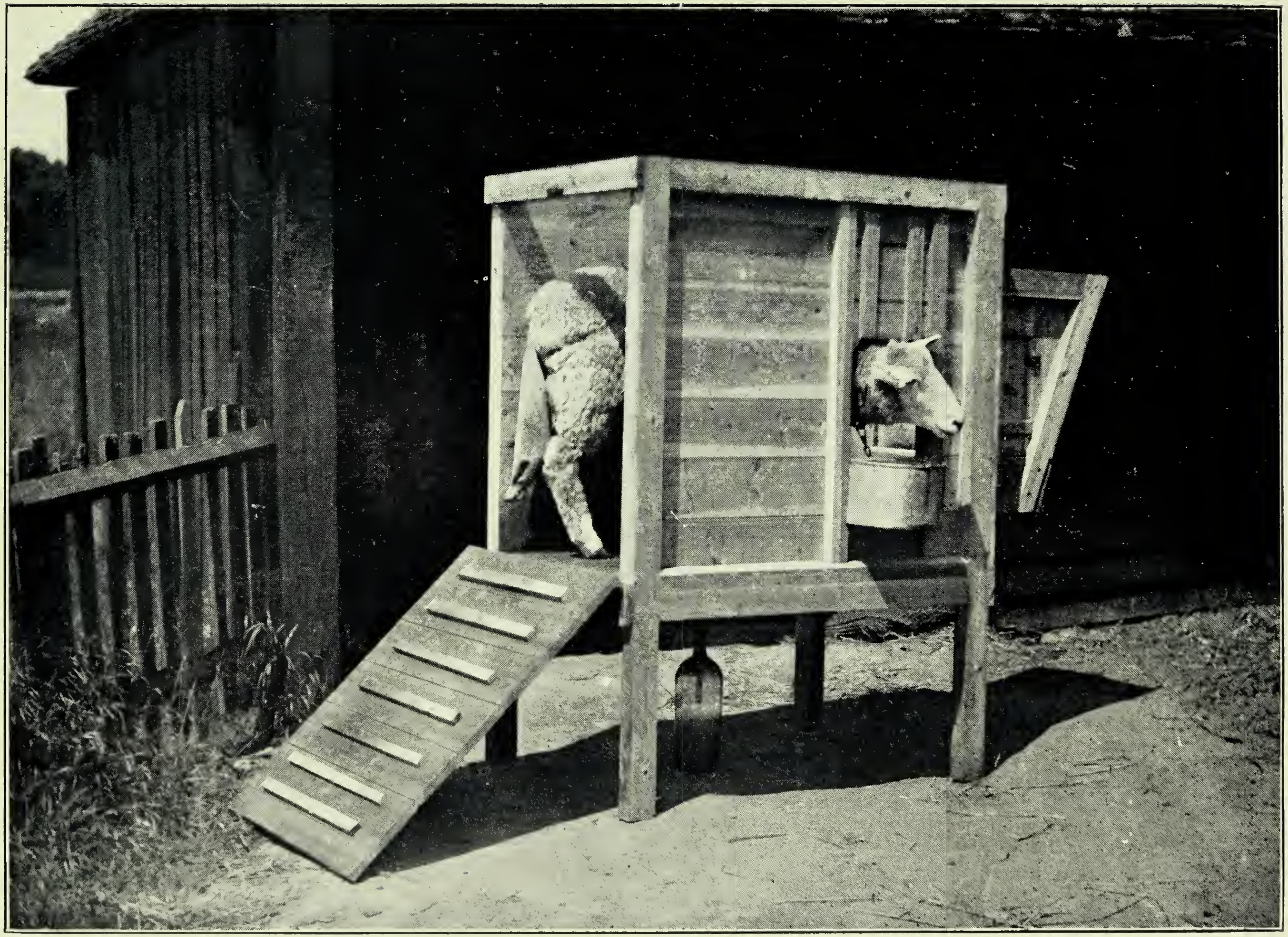
The preliminary feeding should not be less than six days, and then for eight to ten days after that the dung is collected without loss for each period of twenty-four hours. Generally the bags are emptied two or three times a day at regular intervals, and the food must also be given regularly. If, then, a further period follows, say the hay test, then eight to ten days more are essential for the collection of dung.

The dung, when taken from the bag, is weighed, thoroughly mixed and after carefully drying at a medium temperature, is left for a time to become air dry. It is then subjected to analysis in exactly the same way as the food. This method of working gives all the data necessary for arriving at the digestibility of the concentrated food. If the food to be tested is too poor to admit of being fed alone, some concentrate such as cotton seed meal, earthnut meal, etc., the digestibility coefficients of which have been previously ascertained, is added to the ration, and the investigation carried out as in the first case.

In most digestibility experiments sheep are used, both on account of their size as compared to cattle, and also because the dung is easier to weigh and analyse. Where, for any particular reasons, bullocks have to be used instead of sheep, a special stall is required and the dung is either collected in a suitable bag or else allowed to fall into a channel behind the animal, and then scraped into a metal box sunk at one end of the channel.

The analysis of the food and dung, and the general method of feeding are exactly as described for sheep.

The differences in digestive power between cattle and sheep for ordinary rations is small, so that the results obtained with sheep



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can be applied in fixing a ration for cattle without any serious error being made.

Experience and experiment have shown that cattle possess a slightly higher digestive power than sheep, the difference being most marked in the case of the coarse fodders.

It is along lines similar to these sketched above that it is proposed to begin digestibility trials at this College, and it is hoped that when the initial difficulties have been surmounted that information useful to the owner of fattening and dairy stock, and to the sheep rearer, will be obtained and published.

FEEDING OIL TO MILKING COWS.

By J. Mackintosh, N.D.A., N.D.D.; and W. Goodwin, B.Sc., Ph.D.

The question as to whether it is possible to increase the amount of butter fat in milk by feeding foods rich in oil, has been repeatedly tried and with varying results. Generally the oil was given in the form of oil cakes which, being also rich in protein, are hardly comparable to the oil itself, even when the rations are calculated to contain equivalent quantities of protein. Records of experiments in which the oil or fat was simply added to the ration are not very numerous. The first of these is that of G. Kühn in 1868, who fed a ration to which he added rape oil. The results which were obtained seemed to show that with cows an increase of fat in the food exercised no appreciable effect upon the amount of fat in the milk.

Another investigation by Fleischer about the same time yielded similar results. Where goats were experimented upon instead of cows the conclusions drawn by Stohmann were different, for he found that an addition of oil to the ration caused both the yield of milk and the percentage of fat it contained to increase.

Investigations conducted by Wood in 1896, and also by Van Dreser, in which different fatty substances—cotton seed oil, palm-nut oil, cocoa butter, tallow—were fed in addition to the ordinary ration, showed that for a time the fat in the milk increased, but that after one or two weeks it sank again to the normal.

At Cornell Experiment Station, Wing fed tallow to milch cows in addition to other food. The amount of tallow was gradually increased until after the fourth week, each cow was getting two pounds daily. The experiment was continued for six weeks, whilst this amount was given. It was found that, in spite of the added tallow, there was a gradual decrease in the yield of milk, and that the percentage of fat remained almost unchanged.

On the other hand T. Soxhlet used sesame oil, linseed oil and tallow in the state of emulsion which, instead of being given with the food, was added to the drinking water. He reported an increase in the amount of fat in the milk. These results, which are more satisfactory than those previously recorded, gave rise to a considerable number of experiments, in which the extra oil was given in the form of cake ; but these not being strictly comparable to the experiment about to be described, scarcely require to be discussed here. It may be noted though that the results were not conclusive ; in some cases a slight increase in the amount of butter fat was reported, but the quantity in all cases was small.

As regards the influence which the food fat has upon the butter fat, there are plenty of cases recorded where a softening or hardening effect upon the butter has been produced. Practical experience has also shown that certain foods can be used to correct a tendency to hardness or softness in the butter. Thus, linseed cake and meal, if given in fairly large quantities, produce a soft, greasy butter ; whilst cotton seed cake and cocoanut cake have the opposite effect. Rape cake is also credited with having a hardening effect upon the butter.

The chemical composition of the butter fat, as is to be expected, also undergoes change, and this is sometimes of commercial importance. The Reichert-Meissl value of the butter, which is based upon the percentage of volatile fatty acids present, is one of the standard methods adopted for the detection of adulteration, and it is important to find out whether any new foods influence the butter, so as to bring it under suspicion.

During the months of April and May of this year an experiment was carried out on the effect of feeding earthnut oil and cocoanut oil direct to milking cows, with the object of finding out if either of these, which are easily procurable, could be utilised to increase the percentage of fat in milk, and beneficially affect the quality of the butter produced. Earthnut oil is obtained from earth nuts ((*Arachis hypogaea*), known familiarly in this country as monkey nuts. The plant which produces these nuts is a suptropical annual of the order Leguminosæ. They are exported principally from the west coast of Africa to Marseilles, where, after being freed from the husks, and sifted, they are pressed between cloths, and yield an oil which is used for table purposes. The residue, after further extraction to remove as much oil as possible, is known as "earthnut cake," and is an excellent food for cattle, both on account of the flavour and the large amount of protein and some oil which it contains.

For the purposes of the experiment a medium quality oil, costing about 40s. per cwt., was chosen.

Cocoanut oil or cocoa butter comes from the flesh of the cocoanut, which is known as "copra," and contains 70 to 75 per cent. of oil. This oil is simply pressed out hydraulically, and after purification yields cocoa butter, which is solid at ordinary temperature. As in the case of earthnut oil, the residue remaining after the extraction of the oil is also used for feeding cattle, and is reported to have the property of causing the butter fat to be firm. The price of cocoanut oil is, at present, 30s. per cwt.

This experiment is to be regarded as merely preparatory, the idea being to continue the work next year, at least on some points, should the results warrant it.

OBJECTS OF THE EXPERIMENT.

(1) To find out whether by feeding fat or oil direct to cows the percentage of butter fat in the milk could be appreciably altered.

(2) To ascertain the effect of the oils used on the butter produced, as regards churning, flavour, texture and colour.

(3) To find out the effect of the oil on the Reichert-Meissl value of the butter.

COWS SELECTED.

Three Lincoln Red cows were chosen, which were at about the same stage of lactation :—No. 11 calved on February 12th, No. 14, on February 13th, and No. 18 on February 16th—and which gave approximately equal quantities of milk. More cows would have been included if possible, but the milk of all the others was required to supply the College when the experiment was started.

PLAN OF THE EXPERIMENT.

The experiment was divided into four periods :—

(1) A *Preliminary Period* of twelve days. April 3rd to 15th.
(2) An *Earthnut Oil Period* of sixteen and a half days. April 16th to May 2nd.
(3) A *Cocoanut Oil Period* of seven and a half days. May 2nd to May 9th.
(4) A *Grass Period* of twenty days. May 10th to May 30th.

(1) During the *Preliminary Period* the cows were fed a basal ration, containing the following foods :—

2 lbs. Maize Germ Meal 4 lbs. Dried Ale Grains 1 lb. Molascuit 5 to 6 lbs. Wheat Chaff	All mixed together, soaked with water, and fed moist before the evening milking (3.30 p.m.)
2 lbs. Undecorticated Cotton Cake.	Fed in the morning after milking.
50 to 60 lbs. Mangels (whole).	Part fed in the morning after milking (7 a.m.) Part fed about 2 p.m

Hay as required, fed in the covered yard.

(2) *Earthnut Oil Period.*—The cows received the first allowance of earthnut oil in the afternoon of April 15th, getting 2 oz. each amongst the soaked food before milking. This quantity was increased as follows :—

April 16th.—3 ozs. each in afternoon before milking.

April 17th to 21st.—4 ozs. each in afternoon before milking.

April 22nd to 23rd.—3 ozs. each in morning and afternoon before milking ; the quantity of soaked food being also divided but not increased.

April 24th to May 2nd.—4 ozs. each morning and afternoon before milking ; given as above.

On the first occasion the oil was partially emulsified with water and mixed with the dried grains, etc., just before the latter was placed in the cow's trough. The next few days one pint separated milk was used in each case, a much better emulsion being obtained, but afterwards the oil was brought to a liquid state, and mixed directly with the food. On every occasion cows No. 14 and 18 ate the food with eagerness, but No. 11 was as slow with this food as with all others, often leaving the greater part of it till after she had been milked.

(3) *Cocoanut Oil Period.*—On May 3rd and 4th, 3 ozs. cocoanut oil was fed night and morning, exactly as the earthnut oil had been given ; from May 5th to 9th, the quantity was increased to 4 ozs. Though this oil has a higher melting point, and was occasionally fed in a semi-fluid state, the cows ate the food with the same relish as previously.

(4) *Grass Period.*—At the beginning of this period the cows were turned out to the grass during the day, some concentrated food being given indoors. Later, mangels were given in the field, and after the 17th May, the cows were out all night ; only getting two to three lbs. Undecorticated Cotton Cake and Maize Germ Meal in the cow-house at milking time.

MILKING AND SAMPLING.

The cows were milked twice a day, at 5.45 a.m. and 3.30 p.m. Nos. 11 and 18 were milked by the same persons throughout, but No. 14, being quieter, had different milkers on several occasions. Samples were taken from the milk of each cow night and morning, and tested by the Gerber method. The milk, after weighing, was kept apart from that of the remainder of the herd, and immediately separated, the cream being kept and churned by itself, so that all peculiarities could be carefully noted, and a representative sample obtained.

RESULTS.

I. Effect of Oil on the Quantity of Milk.

The addition of the oil to the basal ration did not cause any appreciable increase in the yield of milk ; the slight variations noticed are quite natural. There is a slight increase in the evening yield of No. 18, and to a less extent in that of No. 14.; the last period is credited with slight rise due to the new grass. The difference between the morning and evening yields, it may be noted, shows a tendency to diminish.

Average Daily Yields of Milk in lbs.

Cow.	Time.	Preliminary Period. 12 days.	Earthnut Oil Period. 16½ days.	Cocoanut Oil Period. 7½ days.	Grass Period. 20 days.
No. 11	Morning	21.39	20.52	20.50	20.32
	Evening	14.20	13.71	13.46	13.77
	Daily	35.59	34.23	33.96	34.09
No. 14	Morning	20.06	19.75	18.32	18.38
	Evening	13.75	14.46	14.28	14.67
	Daily	33.81	34.21	32.60	33.05
No. 18	Morning	18.75	18.38	18.67	17.48
	Evening	12.31	14.26	14.43	15.21
	Daily	31.06	32.64	33.10	32.69

II. *Effect of Food on the Quality of the Milk.*

The daily testing of the samples of milk brought to light one or two interesting facts regarding the individual cows, but it cannot be said that the addition of the oil made any noteworthy alteration in the quality of the milk. There was a slight increase immediately after the addition of the earthnut oil, but by the third day the milk was of the same average quality as that of the preliminary period.

With regard to cows, Nos. 14 and 18, there was a gradual increase in the quality of the evening's milk throughout the oil periods, then a decided drop in the quality of that of both milkings during the grass period. The high quality of No. 14's milk during the cocoanut oil period must be partially attributed to the fact that the cow came in season.

The richness of the morning's milk and corresponding poorness of the evening's milk from No. 14 during the grass period is accounted for by the fact that that cow was occasionally milked by inefficient students.

It is worthy of note that cow No. 18 gave decidedly the poorer milk in the morning and the richer in the evening. The individual variation was very marked in all cases.

Average Percentage of Fat in the Milk :—

Cow.	Time.	Preliminary Period. 12 days.	Earthnut Oil Period. 16½ days.	Cocoanut Oil Period. 7½ days.	Grass Period. 20 days.
No. 11	Morning	2.68	2.71	2.60	2.54
	Evening	3.49	3.49	3.63	3.18
	Daily	3.08	3.10	3.11	2.86
No. 14	Morning	2.77	2.95	2.95	3.26
	Evening	3.38	3.48	3.93	2.97
	Daily	3.07	3.21	3.44	3.11
No. 18	Morning	2.46	2.28	2.44	2.17
	Evening	3.56	3.90	3.93	3.73
	Daily	3.01	3.09	3.18	2.94

The above results support those experiments which showed that when a satisfactory ration is fed to cows, any addition to or change of the food makes no permanent change in the percentage of butter fat in the milk ; after a slight increase the milk resumes its normal condition.

It might be inferred that the fall in quality after the cows went out to grass was partly due to the want of the oil, but as the milk of the other cows in the herd likewise fell in quality during this period it is more likely that the true cause is the altered conditions, *i.e.*, spending the night out-of-doors instead of in a warm cowhouse or covered yard. The grass may have had something to do with the fall in quality, but there are many records of cases where the grass has increased the quality temporarily, so no definite deduction can be drawn from the above figures on this point.

III. Effect of Oil on the Quality of Butter.

(*a*) *Preliminary Period.*—During this period the cream was churned while still almost sweet, the weather being too cold to allow natural ripening to take place in the two days which it was kept before churning. The butter was of good quality, but slightly deficient in flavour, and distinctly pale in colour, owing to the cows being entirely on winter feeding.

Details of Churning. (Six Churnings.)

Churning Temp.	Time till Breaking.	Temp. at Breaking.	Temp. at Washing.	Temp. of W. Water.	Temp of Brine.
58°-60°	Av. 24	58°	54°-57°	50°	47°-50°

Brine at 50° made the butter too soft, hence it was difficult to work satisfactorily, while brine at 47° hardened the grains, so that it was difficult to make the butter gather on the worker. Brine at 48° to 49° gave the best results.

(*b*) *Earthnut Oil Period.*—There were in all eight churnings of cream obtained during this period. Only on the last three occasions could the cream be called ripe ; before that, it was usually only very slightly sour.

The butter made from the first two churnings was very similar to that of the first period, only of a distinctly superior flavour the later churnings yielded butter of poorer, though still satisfactory flavour, of much softer consistency and decidedly oily in appearance.

The cream used in the last three churnings, though markedly sour, was increasingly difficult to churn, 40 to 45 minutes being required to get it to break, even with the addition of a little hot water, and the butter, though washed by a cooler brine, became very soft in the working and did not make up well. There was no alteration in the colour.

Details of Churning. (Eight churnings).

Churning Temp.	Time till Breaking.	Temp. at Breaking.	Temp. at Washing.	Temp. of Washing Water.	Temp. of Brine.
58°-60° F.	21-45	57½°-62°	55°-58°	49°-50°	48°-49°

The above results show that a small quantity of earthnut oil (2-4 oz. per head per day) tends to improve the flavour of winter produced butter, but larger quantities make the cream too difficult to churn, the butter too soft to be easily handled, and too greasy to be appetising in appearance.

(*c*) *Cocoanut Oil Period* (three churnings).—It was only possible to have three churnings of the cream obtained during this period but these were sufficient to bring out the characteristic effects of the oil. In all cases the cream was at the correct stage of ripeness, and the weather conditions were much milder than during the previous periods, yet it was found desirable to churn at even a higher temperature in order to get the butter in a reasonable time. A larger churn was used on the last occasion, and the greater concussion resulting caused the butter to break more quickly. After breaking it was very difficult to get the minute grains to unite to form sufficiently large ones, but by using brine at 50° it was possible to get the butter together quickly on the worker. The flavour and texture of this butter was splendid considering the temperatures, and the butter handled firmly and easily in the making-up. The colour remained pale, but otherwise there was a marked difference compared to the butter of the previous period.

Details of Churning (three churnings) :—

Churning Temp.	Time till Breaking.	Temp. at Breaking.	Temp. at Washing.	Temp. of W. Water.	Temp. of Brine.
58°-60°	55-40-20	62°	57°-59°	49°-52°	49°-50°

From the above it will be seen that the cocoanut oil had an immediate effect on the quality of the butter produced. It made the cream difficult to churn, but had a decidedly hardening effect on the butter, which was of good flavour, texture and appearance. it had no tendency to greasiness, and was a marked contrast to that produced by the earthnut oil.

This hardening effect of cocoanut oil might be made use of practically by feeding 2 to 4 ozs. per head per day during the hot days of summer, when the butter is usually to soft to be handled satisfactorily. A trial of this is in contemplation.

IV. Grass Period.—

It was found impossible owing to other circumstances to continue the special churnings during this period ; but this was not so important as the effect of young grass on the texture and colour of butter is well-known. The milk, after weighing and sampling, was mixed with that of the remainder of the herd and all churned together.

THE REICHERT MEISSL VALUE OF THE BUTTER.

This was determined in the usual way, the only modification being Leffmann and Beam's method of saponifying the butter fat with strong caustic soda solution and glycerine instead of using alcoholic potash solution. The following numbers were obtained. but the length of the experiment was not sufficient to warrant any definite conclusion being drawn from them.

		Reichert Meissl Value.
Six churnings. No extra oil given.	April 6th	31.24
	April 9th	33.22
	April 11th	34.32
	April 13th	33.55
	April 15th	33.66
	April 18th	34.54
Eight churnings. Earthnut oil given.	April 21st	33.88
	April 23rd	34.54
	April 25th	32.67
	April 27th	33.99
	April 28th	33.77
	May 1st	32.78
	May 4th	31.35
	May 5th	31.46
Three churnings. Cocoanut oil given.	May 7th	32.45
	May 9th	31.61
	May	

It will be seen though that the Reichert Meissl value became smaller under the influence of the oil in both cases, and further, that in no instance did it fall sufficiently low to approach the usually recognised minimum of twenty-four. A much longer trial, however, would be necessary before any definite conclusion could be arrived at, respecting the effect of such vegetable oils upon the Reichert-Meissl value. A still further lowering of the number might reasonably be expected.

GENERAL CONCLUSIONS.

(1) That the feeding of earthnut and cocoanut oils to cows does not increase the percentage of butter fat in the milk to any appreciable extent.

(2) That the effect of earthnut oil upon the butter is to render it soft and difficult to work, but that small quantities may slightly improve the flavour of winter produced butter. Cocoanut oil, on the contrary, makes the butter firmer, and of good flavour ; a point it is hoped to investigate more fully.

(3) That under the influence of the above-mentioned oils the Reichert Meissl value falls, but the experiment would have to be carried on for a longer period to obtain reliable data.

A NEW FORM OF DR. RUSSELL'S OXIDATION APPARATUS FOR SOILS.

By Francis V. Darbishire, B.A., Ph.D.

In the Annual Report for 1904 issued by the Chemical Society, Dr. J. A. Voelcker discusses Russell's method of measuring the fertility of a soil by the amount of oxygen which it absorbs and says: "The method, as applied to the soil of different plots and fields of the Woburn Experimental Farm, certainly succeeded in placing them in the order of their respective fertility and Dr. Russell states that this has been the case elsewhere."

Voelcker's brief reference to Russell's researches was made before any particulars had been published, but shortly afterwards a full account of them appeared in the *Journal of Agricultural Science.** In this paper the connection between oxidation and fertility is discussed, and the suggestion made that the rate of oxidation is mainly due to the action of micro-organisms which hasten decomposition in the soil and so render the general conditions more favourable to plant life. There appears then to be a direct connection between these two soil properties—the rate of oxidation and the fertility or productiveness. It has been found that the most productive soil has the highest rate of oxidation, whilst a less fertile one shows a lower rate of oxidation. Any apparatus therefore which furnishes measurements of the rate of oxidation of a soil supplies also information as to its fertility or productiveness.

* *J. Agric. Science, I.*, October, 1905, 261.

Russell states in his paper that the rate at which oxygen is absorbed by a soil can be easily and accurately measured by the method there described. The aim of the proposed modifications is therefore to introduce a simpler form of apparatus which can be more easily charged and read and yet yields results as reliable and as accurate as those obtained by Russell's original instrument.

The diagrams Fig. 1 and Fig. 2 show the relation between the two forms of apparatus and the following description will serve to indicate the advantages which are claimed for the modification.

Russell's oxidation apparatus Fig. 1 can best be described by quoting his own words : "The apparatus which is extremely easy to make, consists of a flask of about 100 c.c. capacity, with two tubes sealed into its neck. The wider of these is bent at right angles and terminates in a bulb B ; higher up is the narrower one C, of about 4 mm. diameter, also bent at right angles, but open at the end. A weighed quantity of the air dried soil is introduced into the flask, a definite amount of water is added, and the neck of the flask is either sealed up or closed with a well-fitting rubber cork. Potash solution is run into B by a little side tube C, which is then sealed, and the end of D is dipped under mercury, thus converting it into a gauge. The apparatus is now placed in a water-bath, and oxygen is absorbed. The absorption of oxygen is indicated by the rise in D and from a measurement of the height of the column above the surface the amount of oxygen taken up is readily found. A cathetometer and millimeter scale are used for this purpose. In practice six or seven soils can very readily be examined simultaneously ; the experimental vessels are made of approximately the same size and the potash solution run into B is in such quantity that the volume of air left is the same in all the vessels. They are then fixed in a curved waterbath, so that all the gauges are in focus simultaneously."

The arrangement of the apparatus is shown in Fig. 3.

After testing several forms of apparatus the one shown in Fig. 2 was found to give the most satisfactory results, and it is the one which it is proposed to use in future work. It was made for me by Mr. Baumbach, of Manchester, the well-known glass-blower.

It consists essentially of a small glass vessel A, 7½ c.m. high, with a diameter of 4½ c.m., and a capacity of about 100 c.c. A

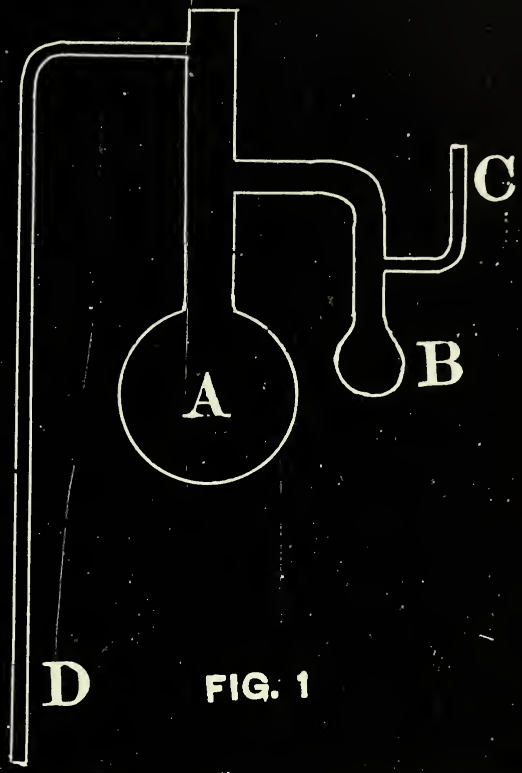

FIG. 1

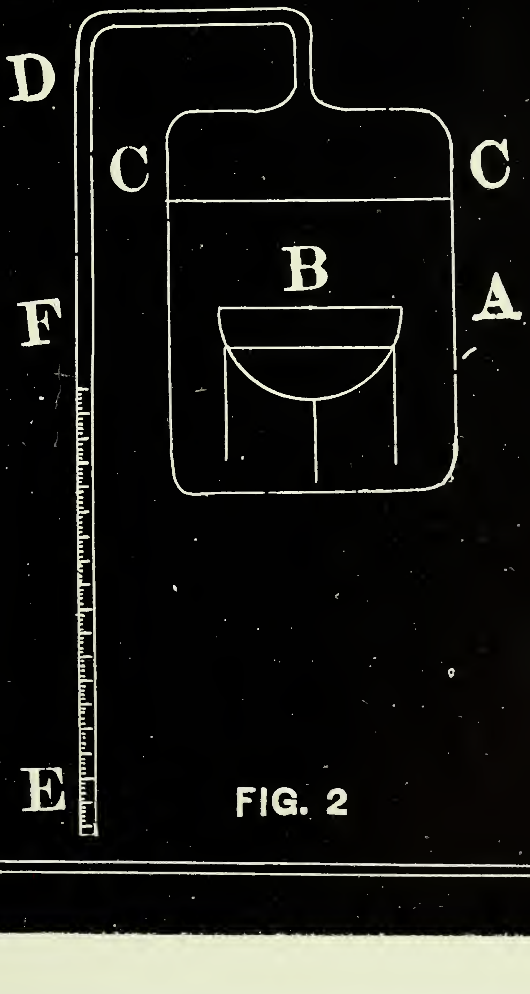

FIG. 2

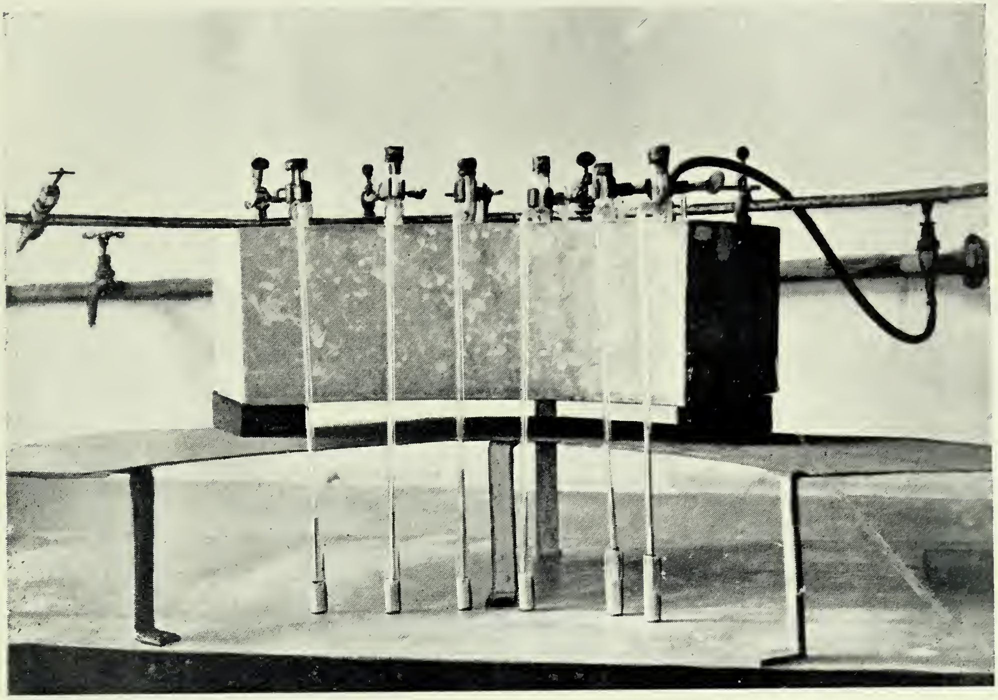

Fig. 3.

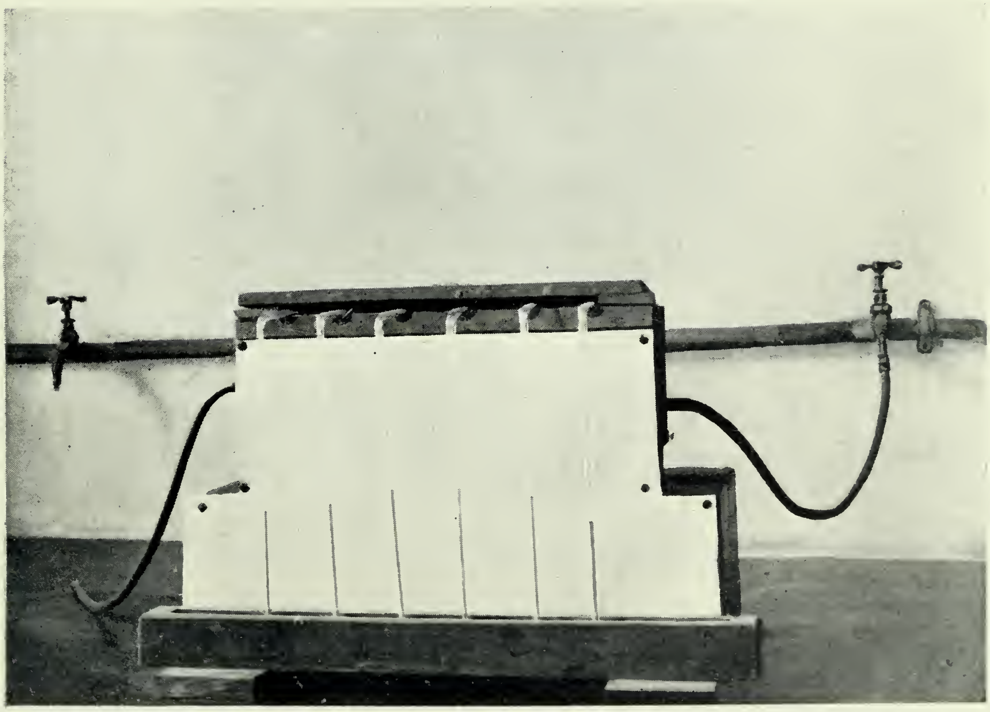

Fig. 4.

F.V.D. Phot.

little glass cup B supported by a small glass tripod is intended to contain the potash solution, by which the carbon dioxide is absorbed. In order to insure the connection at C-C being thoroughly air-tight, the glass stopper is carefully ground in ; each vessel and each stopper is numbered to correspond. The extension of the stopper is twice bent at right angles ; the longer limb D E, having a scale E engraved upon it, acts as a mercury gauge. Fig. 4 is a photograph of the arrangement of a series of them taken after an examination of a soil had been in progress for some time. The wooden case contains a water-bath, through which water is allowed to flow. Immediately above the bath is a shelf furnished with round holes, into each of which one of the apparatus is placed. Each mercury gauge rests in a groove cut in cork, which is let into a board attached to the box. As the gauges are of the same length they can all conveniently be made to dip into the same narrow mercury bath. They are held in position by a piece of wood, which fits closely on to the top of the box.

When the apparatus has been carefully cleaned and dried, the soil under examination is transferred to it by the following series of operations which can be very speedily carried out. Ten grams of the soil, air dried are finely ground in a mortar and placed in the vessel A, 2 c.c. of distilled water are then added from a pipette and uniformly distributed throughout the soil. The tripod and cup having been placed in position, a small quantity of potash solution is run into the latter and the vessel closed by the stopper, whose ground surface has been rubbed with vaseline. Finally the mercury is made to rise a short distance in each mercury gauge by sucking out some air, and the whole apparatus slipped into position in the bath. After about twelve hours, the first reading can be taken. Owing to the fact that the level of the mercury in the trough is, of course, the same for each tube, and the fact that each tube has its own scale, the daily readings do not require much labour. All that is required is to read directly on the scale the actual position of each column of mercury, and to correct for barometric changes, in order to make the heights comparable with the first day's reading. For this purpose, one or two blanks are introduced into each series. The difference between the last reading and the first is a measure of the amount of oxidation that has taken place.

The apparatus is now being tested with respect to its possible application to various subjects connected with soil bacteriology at present under investigation. From the progress made by these experiments so far, the conclusion may be drawn that this form of apparatus is suitable for such purposes, inasmuch as a considerable number of uniform results have already been obtained; and also that the method of using it presents no difficulties, either as regards setting it up in readiness for an experiment or taking the necessary readings.

The results of an actual experiment taken from among several others is added, in order to illustrate the uniformity that may be obtained. A, B and C were samples of soil deficient in lime; on A and B clover was reported to be doing badly, on C fairly well. D is a healthy, fertile soil with 1.6 per cent. of lime.

	2 days.	4 days.	5 days.	7 days.
A.	0.6	2.7	4.0	7.7
B.	0.5	2.6	3.6	6.9
C.	1.7	4.9	6.2	11.2
D.	3.3	7.9	11.5	15.7

REPORT

FROM THE

BOTANICAL DEPARTMENT.

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EXPERIMENTS IN SMUDGING.

By S. T. Parkinson.

Owing to a re-awakening of interest in the use of smudge fires as a possible means of protection of fruit trees against frost the College determined to continue experiments begun here last year.*

Through the kindness and co-operation of Mr. Ivo Neame, at Lower Ensden Farm, Chilham, and Mr. E. J. Overy, at Mascall Court, Paddock Wood, we were able to arrange and watch the working of the experiment on a practical basis and although we were so free from severe frosts this year that it was impossible to test the saving effect of the fires, some progress was made in discovering the best method of arranging the apparatus and in estimating the cost of material.

The following notes, relating principally to the experiments conducted at Lower Ensden Farm, may be of interest.

The method employed was that of making a hot black smoke by burning a mixture of naphthalene and creosote in the specially made iron pots recommended by Mr. Geoffrey Hooper in the *Journal of the Board of Agriculture* of April last year.

The pots, forty to the acre, were distributed in rows in a plantation of plum trees with gooseberries underneath, so that each row of pots was about ten feet from the next and the pots in the rows were also ten feet apart.

The pots about a foot high, narrower at the top than the bottom and provided with holes for ventilation near the top, are made of thin iron rolled over at the joints, instead of being soldered, in order to resist the heat.

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* See "Damage done to Fruit Trees by Frost" in *The Journal* for 1907.

These, each one filled with over a gallon of the fluid, were placed *in* the rows of gooseberries, just when the flowers were beginning to open and were left in the plantation during the whole of the experiment.

In this position they were easily available when wanted for lighting and did not interfere with cultivation of the ground.

Some sort of cover had to be arranged for each pot to prevent any excessive amount of rain from getting into the mixture and it was found that an old tile was convenient and perfectly satisfactory for this purpose.

A handful of dry wheat straw, which burns more readily than that of oats or barley, was placed in each pot when there were signs that a frost might be expected.

On a clear night, when there seemed a prospect of a sharp frost, the pots were lighted as soon as the mercury in the thermometer fell a little below the freezing point.

This early lighting up appears to be necessary, if, as is generally supposed to be the case, the chief effect of the smudge is to prevent loss of heat by radiation from the ground and trees. Since this loss by radiation is often greatest just about sunrise or even a little after, the fires if lit should be kept going for an hour or two after the sun appears unless the weather becomes cloudy and the temperature has risen.

The lighting-up is easily carried out by one man going round with a well-prepared torch. He first lifts the pot out from under the bushes to the middle of the space between the rows, as far from any foliage as possible and on applying the torch the fuel immediately ignites. At first there is a good deal of flame, but after a few minutes this gives place to a heavy black smoke.

Lighting up forty pots took twenty minutes.

A very effective torch was made by wrapping cotton waste round the end of a stick, binding it loosely with wire, and soaking the wrapped end in a bucket of paraffin. The wooden handle burnt through after a time, and a piece of twisted iron rope would have served better.

If the pots are lit up early (say at 9 p.m., as was the case with us on the 24th of April) and the frost continues till sunrise, they will need relighting.

This operation gave us considerable trouble. It was effected by means of watering cans filled with the fuel. A good deal of time was lost in filling up these cans from the casks as the fuel runs somewhat slowly.

If a large acreage had to be smudged, it might be advisable, in order to save time, to have the fuel drawn off into a moveable tank and fill the watercans with dippers or pails, or else to knock in the tops of the casks.

Another difficulty arose from the fact that when the fresh fuel was poured into the pot, it put the fire out and we had to put another wisp into each pot and light up again.

Refilling the pots in the dark is a very awkward operation, and we found an acetylene bicycle lamp of great assistance. It took three men a considerable time to refill and relight the forty pots that, at the start, had easily been managed by one. Also some caution is necessary, in dealing with the naphthalene mixture, to avoid breathing the heavy fumes given off as well as on account of its inflammability.

When the pots are once burning they require very little attention unless the wind freshens or changes in direction.

The burning creosote forms a dense, black, dirty " blanket " or cloud, which on a still night hangs a few feet from the ground. This " smudge " may produce several distinct effects. It is claimed that it produces an appreciable rise in temperature, but this is not definitely established. On the 20th April, a thermometer outside the smudged area at Paddock Wood " showed six degrees of frost, while one placed in the middle of the smudge showed only about one degree."

At Lower Ensden Farm minimum thermometers in the " smudge " area showed very little difference compared with those just outside, though they indicated three or four degrees less frost than others placed outside further down the slope. The situation, nature and slope of ground and the character of the trees and bushes all affect the readings, and thermometers a very small distance apart often show considerable differences. It is a well-known fact that one plantation may suffer severely from frost while an adjacent one escapes damage.

A more certain effect of the cloud is that it reduces the loss of heat by radiation. It can thus prevent the fall of temperature in the night, hence the necessity for lighting up *before* the frost becomes severe, especially on a still, clear night, when loss of heat by radiation is greatest.

The cloud may also act as a protection against sudden thawing by the morning sun, although experiments on artificially frozen plants indicate that less damage is due to this cause than is generally supposed.

On the 20th April, the night was clear and starlit, and the wind, which had been blustery, dropped to an almost imperceptible north-westerly breeze. At 9.30 p.m. the thermometer fell to freezing point and the pots were lighted.

The flare from the pots soon subsided and a dense cloud settled over the plantation. This was most compact at a height of from twelve to twenty feet above the ground and hung about in that position till about 3 a.m., when it lifted, the smoke from each pot going almost straight up for some distance before being blown away. The breeze meantime had backed round to the south-west. While the cloud was still hanging, the breeze caused it to spread to leeward, where it still hung well together over about fifteen rows of gooseberries, so that the last two rows of pots on the leeward side need not have been lighted, but on the other hand when the wind backed they were required.

Although the cloud enveloped the plum trees almost completely, it failed to do so as regards the lower-growing gooseberry bushes, which were practically clear of the smoke, and it is a point for consideration whether, even if effectual in protecting the taller fruit trees, it would be of use for low-growing fruit, such as the gooseberry.

On examining the bushes next day, no scorching was found except on a small branch almost touching one of the pots, but the bushes near the pots were covered with a solid layer of large, oily, black, clinging smuts. In the course of a few days of rain and snow this was washed off, the fruit and leaves showing no trace of harm. It would evidently be impracticable to smudge where rhubarb or other low-growing plants and vegetables nearly ready for market are grown between the rows, as the smuts are very dirty and difficult to remove, and it would also be out of the question to do so where the plantation is close to houses or in a town or village, on account of the dirty smoke.

Whatever the nature of the weather may be, whoever is responsible for the smudging must be on the watch for a coming frost during the whole of the flowering season.

Although much may be done in the way of predicting frosts, the safest way, and that which saves most trouble in the end, is to have some sort of alarm thermometer fixed up in the neighbourhood of the plantation which, as soon as the temperature falls low enough, automatically rings a bell in the room or hut where the watcher is sleeping.

A very simple form of such a thermometer was supplied to us. It practically consists of a "Six's Thermometer" with the two index bars taken out, and one piece of platinum wire fused into the glass where the freezing point (or any other required temperature) is marked on the "minimum" side of the instrument, and another near the bottom of the tube. The latter wire is always in contact with the mercury column, and the former is touched by it as well, as soon as it rises as far as the freezing point. In this way a metallic connection is made between the two wires, and if these are connected with an ordinary dry battery cell and an electric bell in the usual way, the bell starts ringing. These thermometers are simple, and, if set up properly, reliable enough.

Dealers ask a somewhat high price for the thermometer, but the rest of the apparatus can be obtained anywhere very cheaply, and is easy to set up. The instrument should be tested every night by laying a knife blade across the two brass screws fitted to the platinum wires on the thermometer, so as to touch both at once. The bell should start ringing vigorously, but stop the moment the knife is taken away.

Our outfit consisted of :—

Thermometer,

Twenty-four yards insulated wire, Electric bell, Two dry-battery cells, Switch,	These cost about seven shillings.

The Fuel.

Inquiries were made at several chemical manufactories and gas and tar works and samples of a good many substances were tried, but none of these have been found more effective than a mixture of naphthalene and creosote, as recommended by Mr. Geoffrey Hooper. The price quoted for crude naphthalene was found to vary from £5 to £2 per ton.

A sample at the latter price was used in making the following trial. In each case the solid naphthalene was added to ordinary creosote in one of the "smudge pots."

No. 1. 4 pints naphthalene.
4 pints creosote.

No. 2. 2 pints naphthalene.
6 pints creosote.

No. 3. 6 pints naphthalene.
2 pints creosote.

No. 4. 5 pints naphthalene.
3 pints creosote.

No. 5. Bought mixture, liquid, (4d. per gallon, railway carriage additional).

No. 6. 4 pints napthalene.
4 pints anthracene oil.

The most successful were Nos. 1, 2 and 3; No. 3 perhaps the best. They all burnt with a very black smoke and all had to be stirred round with a rod at the start. No. 4 did not burn very well, although the quantities came between Nos. 2 and 3.

No. 5 was not so dense as either Nos. 1, 2 or 3.

Nos. 1, 2, 3 and 4 burnt well for three-and-a-half hours; No. 5 for four hours, but was much thinner at the end.

The naphthalene is added to the creosote to make the smoke thicker and to cheapen the mixture.

Smudging carried out in the manner described is a somewhat costly operation.

We estimate that, doing say five acres at a time, the cost per acre for one smudging works out somewhat as follows :—

	s.	d.
Forty gallons fuel at 4d.	13	4
Carriage of same	5	10
Labour of attention		10
Carting stuff, setting out pots, filling and preparing	1	0
Straw for starting	1	0
Towards cost of pots (9d. each)	3	4
	25	4

If a refill is necessary, the cost would be about twenty-two shillings more, nearly double.

By mixing the naphthalene and creosote on the spot, the cost would probably be less by four to five shillings on each forty gallons of mixture made.

The smudge pot has two or three apparent advantages over the older methods of burning rubbish, straw, etc. The material is easily handled and the pots are easily moved from one plantation to another and can be put right in amongst the fruit. There is less fear of scorching the branches of trees and bushes by fire suddenly breaking out in material near them. The cost of labour is less. The heat and smoke are spread uniformly over the plantation. There is no fear of the spread of fungus disease or weed seeds as in the case of hedge clippings, old hop-bine, and such like material hanging about the plantation. It has also been suggested that the oil may to some extent keep off insect pests.

On the other hand, the cost of the fuel is, at present, expensive, and the mess made by the black smuts is very objectionable.

It must be further borne in mind that, so far, only a few trials of this method have been made in this country, and more are necessary before we can regard its efficacy as proved.

BOTANICAL ANALYSIS OF THE EXPERIMENTAL PLOTS ON WOOD FIELD.

By C. J. ALEXANDER, W. B. BURGESS and R. V. O. HART-SYNNOT.

The object of this analysis was to observe what effect the different manurings have had on the relative proportions of the different plants and groups of plants growing in this field; but owing to the fact that no analysis was made before the experiments were begun and that there is no unmanured plot, it is not possible to determine what amount of the variation observed is due to the manuring and what to the original differences in different parts of the field. However, it is safe to conclude that basic slag greatly encourages Black Medick and Suckling Clover; whereas superphosphate alone, nitrate of soda alone and sulphate of potash alone do not encourage these plants.

On Plot 1 there was a good growth of grasses well-filled up with suckling clover; the lower half was markedly heavier, we believe on account of a former dressing having extended that far: it yielded 47 cwt. Plot 2 was equally strong, but with less clover: 42 cwt. Plot 3 (23 cwt.) and Plot 4 (15 cwt.) were very similar in appearance, having a very poor growth of both grasses and clovers. Plot 5A (25 cwt.) showed a good quantity of grass with plenty of medick and suckling. Plot 5B (33 cwt.) differed from it in bearing much more medick.

The weeds did not show much on any of the plots; cat's-ear (Hypochœris) was the most conspicuous; after the hay was carted, a good deal of Crepis virens (a late-flowering hawkbit) appeared.

To determine the composition of the herbage on the plots, a number of small wisps, together making a good handful, of the half-dry swath were taken at random from each plot ; these were brought into the laboratory and the flowering shoots of the various species were separated out and weighed when dry ; the leaves, owing to the difficulty of determination in some cases, were weighed together and appear in the table as " loose hay " : they were chiefly cocksfoot and golden oat ; the shed seed, flowers and leaflets are called " chaff " : they were chiefly soft brome and suckling clover.

In Plot 4 the number of culms was counted ; the number in one grain was as follows :—Cocksfoot, 3 ; soft brome, 8 ; rye grass, 9 ; Yorkshire Fog, 11 ; dogstail, 12 ; twitch, 15 ; golden oat, 16 ; rough-stalked meadow grass, 21 ; red fescue, 28.

The figures in the table probably give a fair idea of the proportions of the different plants in the hay, as they agree in general with the results of an inspection of the plots several days before the grass was cut.

See Table pp. 244 and 245.

Plants which were noticed occasionally during the inspection, but did not appear in the samples, are :—

Grasses.—Alopecurus pratensis (foxtail), Arrhenatherum elatius (tall oat), Koeleria gracilis, Briza media (quaking grass), Brachypodium sylvaticum, and Hordeum nodosum.

Other plants.—Silene latifolia (bladder campion), Linum angustifolium, Lathyrus Nissolia (grass vetch), Chrysanthemum leucanthemum (ox-eye daisy), Centaurea nigra (knapweed), Crepis taraxacifolia, Taraxacum officinale (dandelion), Convolvulus arvensis (bindweed), and Rumex Acetosa (sorrel), the last named only on the super plot.

Botanical Analysis of the Experimental Plots in Wood Field.

(The figures represent percentages by weight).

Plot	I.	II.	III.	IV.	Va.	Vb.
Dressing	4 cwt. Super. 4 cwt Kainit. 1908.	4 cwt. Super. 1906.	1½ cwt. Nitrate. 1906.	1½ cwt. Sulphate of Potash. 1906.	5 cwt. Basic Slag. 1908.	10 cwt. Basic Slag. 1908.
Loose hay	14.8	13.0	14.0	13.4	12.8	10.5
Chaff	5.7	3.9	2.5		3.1	2.7
Undetermined	20.5	16.9	16.5	13.4	15.9	13.2
Black Medick	3.4	0.1	3.6	4.6	23.8	50.5
Suckling Clover	25.1	8.1	2.6	1.5	20.0	17.5
Red Clover	1.0	0.6	0.4	0.0	1.1	0.0
Dutch Clover	0.1	0.0	0.0	0.1	0.1	0.2
Bird's-foot Trefoil	0.0	0.0	0.9	1.5	0.6	1.4
Tufted Vetch	0.0	0.0	0.0	0.0	1.4	0.0
Leguminous Plants	29.6	8.8	7.5	7.7	47.0	69.6
Dogstail	10.0	15.5	19.3	22.0	4.9	3.4
Golden Oat	5.3	18.1	17.4	21.0	12.3	3.2
Perennial Rye Grass	19.3	24.9	15.3	11.0	1.8	1.9
Red Fescue	2.1	0.3	2.4	1.5	2.4	1.6
Yorkshire Fog	4.1	4.7	3.7	7.8	1.7	1.3
Soft Brome	3.7	3.3	1.0	3.3	7.3	0.9
Twitch	0.5	0.8	2.8	1.4	0.7	0.8

Plot Dressing	I. 4 cwt. Super. 4 cwt. Kainit. 1908.	II. 4 cwt. Super. 1906.	III. 1½ cwt. Nitrate. 1906.	IV. 1½ cwt. Sulphate of Potrsh. 1906.	VA. 5 cwt. Basic Slag. 1908.	VB. 10 cwt. Basic Slag. 1908.
Cocksfoot	2.0	0.7	6.3	2.2	2.0	0.4
Rough-stalked Meadow Grass	0.8	1.4	0.7	1.2	0.1	0.3
Timothy	0.2	0.2	0.4	0.0	0.0	0.0
Grasses	48.0	69.9	69.3	71.4	33.2	13.8
Cerastium vulgatum	0.5	1.9	0.4	1.1	1.3	1.6
Hypochœris radicata	0.1	0.2	2.8	2.4	0.0	1.8
Plantago lanceolata	0.4	1.9	2.0	3.5	1.4	0.0
Cnicus arvensis	0.2	0.0	0.7	0.1	0.0	0.0
Equisetum arvense	0.1	0.0	0.5	0.1	0.1	0.0
Ranunculus acris	0.0	0.1	0.3	0.0	0.0	0.0
Sherardia arvensis	0.0	0.5	0.0	0.0	0.0	0.0
Prunella vulgaris	0.0	0.1	0.0	0.1	0.0	0.0
Bellis perennis	0.0	0.0	0.0	0.0	0.1	0.0
Linum catharticum	0.0	0.0	0.0	0.0	0.1	0.0
Geranium dissectum	0.0	0.0	0.0	0.0	0.8	0.0
Others and above in small quantities	0.1	0.0	0.1	0.1	0.1	0.2
Other Plants	1.4	4.7	6.8	7.4	4.0	3.6
Total	99.5	100.3	100.1	99.9	100.1	99.6

REPORT ON

ECONOMIC MYCOLOGY

FOR THE

YEAR ENDING JULY, 1908,

BY

ERNEST S. SALMON, F.L.S., HON. F.R.H.S.

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INTRODUCTORY NOTE.

During the past year specimens of diseased plants, and letters asking for information on subjects connected with fungus diseases of plants and their cure, have been received in considerably increased numbers. Of the diseased plants sent in, many were attacked by those fungus pests mentioned in the "Introductory Note" on p. 267 of the last number of this *Journal;* the remainder were affected with various other fungus diseases. Instead of merely enumerating these pests here, it is proposed to deal with them in detail on a future occasion, when an account will be given of the injuries inflicted on the plants, of the distribution of the pests in this country, and of the remedies.

Mention may be made here, however, of a disease of the Gooseberry caused by a fungus known as *Sclerotinia Fuckeliana.* This disease attacks the stems, branches, leaves and berries; in severe attacks it soon kills the entire bush. Investigations have been made both as to the manner in which this pest attacks the bush, and as to the time when the infection takes place, with the object of enabling remedial measures to be devised. These investigations into the life-history of this pest are now nearly complete, and a leaflet on this disease will be published shortly. Although this *Sclerotinia* disease bears no resemblance to that caused by the American Gooseberry-mildew, a considerable number of specimens have been sent in by growers with letters asking if an outbreak of this mildew had occurred in their plantations. It is desirable therefore to publish a full description of the *Sclerotinia* disease.

During the past months the distribution through Kent and Surrey of the fully-illustrated leaflet* on the American Gooseberymildew has been continued, and numerous lectures on the danger of the introduction of this new pest have been given.

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* This leaflet can be obtained on application to the Secretary.

As a result, a large number of examples suspected of being affected with the mildew have been sent in, Also, visits have been paid to various districts for the purpose of examining gooseberry plantations.

A second case has occured in East Kent of lucerne being attacked by *Urophlyctis Alfalfae*, a fungus disease which was first recorded for England in this *Journal* for 1906, where a full and illustrated description will be found. Farmers in East Kent should keep a sharp look-out for this disease, and prevent this new pest from spreading in the county.

The inquiries that have been most numerous have been those relating to the detection and cure of "apple scab," apple mildew, and "brown rot." Letters asking for the best method of making Bordeaux mixture have been received in increased numbers. In a number of cases visits have been paid to farms, and the quickest, most economical, and most efficient method of making this all-important fungicide has been demonstrated. In this connection, too, a number of farms in Kent, and one in Surrey, have been visited, and demonstration spraying experiments carried out in the orchards or plantations.

Several weeks have been spent in testing, in the College plantation, the various spraying machinery and nozzles, of English and of American make, which are on the market. In this work I have been greatly assisted by Mr. C. T. Gimingham, of the Bacteriological Department. The main results of these trials will be given at a Fruit-growers' Conference, which it is proposed to hold at the College in the latter part of this autumn.

The expenditure of a considerable amount of time has been necessary in order to stimulate the Board of Agriculture to take action against the new potato disease known as "Warty Disease" or "Black Scab." This very destructive disease has been comparatively lately introduced into England, and there is the same necessity for the Board to deal with it before it has spread through the country as exists in the case of the American Gooseberry-mildew.

In order to get the agricultural authorities to take any steps it was necessary first to acquaint growers with the facts of the case.

This involved the sending out of the College leaflet on the disease to leading potato growers and Farmers' Clubs, and also the work of a voluminous correspondence. Resolutions to the Board from Farmers' Clubs in England and Scotland followed; and then deputations, an account of which will be found below at p. 299. At length, the result was achieved of getting the Board to issue an Order making this disease a notifiable one. This is but a small step in the right direction, on the part of the Board, and persistent agitation will still be necessary to stimulate the Board to proceed to track down the disease, to map out the infected areas, and then to deal with them in such a manner as to stamp out the disease.

I should be glad to hear from any potato grower, or Association, who will help in this work of trying to save the potato crop from the heavy losses which must certainly take place if energetic and scientific measures are not undertaken at once by the Board of Agriculture.

The passing of "The Destructive Insects and Pests Act" in July last year was an event which is destined to be of very considerable importance to fruit-growers. Under this Act the Board of Agriculture have at last acquired the necessary legislative powers to deal with fungus and insect pests affecting cultivated plants. In countries such as the United States, where agriculture has not been neglected by the Government as it has been in this country, such legislation has been in force for many years. The passing of "The Destructive Insects and Pests Act, 1907," is an indication that we in England are seeking to draw level with those foreign countries which are ten or twenty years ahead of us, as regards the measures which are taken to look after the interests of the fruit-growing industry.

But we have done little good in obtaining this new law if the State has so organised the Board of Agriculture that its staff does not contain experts who can see that the law is administered in a scientific manner, and with the energy and promptness which are absolutely necessary if measures are to be carried out with success against new plant-pests able to spread at a rapid rate.

It is unfortunately the case that events during the past year have shown that Mr. Spencer Pickering's opinion (as expressed in a letter to *The Times*,*) that the present organisation of the Board is utterly inadequate to deal with the interests of the fruit industry was completely justified. The Board's method of dealing with two new highly destructive diseases affecting plants of great economic importance supplies evidence of the deplorable inefficiency of their present organisation.

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* December 28th, 1906.

Fruit-growers, and all who are interested in the fruit industry in this country, and the means that are taken to develop and protect that industry, should purchase the Annual Report of the Board of Agriculture and Fisheries (Intelligence Division) for 1906 (published in 1908) (price 7d.). Here are set out the various ways in which some of the recommendations which were sent in to the Board by the Departmental Committee appointed by Lord Onslow in 1903 to inquire into the condition of the fruit industry of this country, have been dealt with, or partly dealt with, and the various reasons why the most important recommendations have been passed over. The whole treatment of the question cannot be regarded as anything but extremely unsatisfactory ; this Report, indeed, is mostly of the nature of an elaborate apology.

On the Intelligence side, the lack of scientific knowledge in matters connected with fruit and its diseases has long been apparent. Now that the law is being employed to enforce compulsory measures upon fruit-growers (see p. 256), this want of knowledge threatens to become a serious matter. I have touched on this matter in a paper read to " The Farmers' Club " last April, which is reprinted below at p. 329. But one definite point may be mentioned here, since somewhat misleading information is given on the subject by the Board's apologist in the Report mentioned above.

In December, 1906, I pointed out* that although the American Gooseberry-mildew was known during the years 1901 to 1906 to be spreading very rapidly both in Ireland and on the Continent, and to be inflicting havoc on the crop wherever it became established, the Board took no steps to prevent this pest coming into England or even to acquaint growers with the nature of the disease and to warn them of the great danger of its introduction on imported bushes. I used the following words :—" In 1901, the Board inserted an utterly inadequate paragraph on the disease in their Leaflet on the comparatively harmless European Gooseberry-mildew."

* See *Journal of S.E.A. College*, 1907, p. 313.

No other action was taken. We read now in the Board's Report (p. 49) that the Board's leaflet on the subject was "sufficient to warn growers of the danger." Fruit-growers can judge for themselves. The leaflet in question (No. 52), was issued in 1901; the sole information in it, which relates to the American Gooseberry-mildew, is as follows:—"The American Gooseberry-mildew, met with in considerable abundance in Co. Antrim, Ireland, during the summer of 1900, is much more destructive than its European ally, as it attacks both foliage and fruit. It first appears under the form of delicate white patches which gradually become thick and felty and change to a dingy brown colour, and can be scraped off in flakes." This was the sole information the Board gave to growers from 1901 to 1906; not a word, it will be observed, as to the epidemic nature of the disease, its increasing prevalence on the Continent, and the imminent danger of bringing it into this country by importing bushes. As we know, the mildew was introduced into England, during those years, on both imported standards and bushes. We have now four Inspectors of the Board, as well as local Inspectors, engaged in combating the disease in a number of counties, and the country is saddled with the other heavy expenses connected with the matter; yet the Board hold to the opinion that the paragraph in its Leaflet above referred to was sufficient to warn growers of the danger. I still maintain that it was utterly inadequate. Curiously enough, it happened that one of the growers, in whose plantations this mildew was found first, possessed the Board's Leaflet No. 52. As would be expected, in his case it did not prove sufficient to warn him of the danger, and it had therefore no educational value. This grower referring to the matter at a public meeting held in Eversham in October last, said* "he was the first to observe the mildew in the county, and he found it on gooseberries twelve months ago last spring. There was nothing in the Leaflet issued by the Board of Agriculture to lead him to conclude that it was necessary to take very important measures at the time. He simply sprayed with Bordeaux mixture."

Yet so well satisfied are the Board that in the Report (p. 49) they claim this as an instance in which they gave "timely warning to agriculturists of the ravages of pests." The Board show a curious reluctance to see things as they are.

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* Evesham *Standard*, October 5th, 1907.

The uncertain or even erroneous information on scientific points which the Board have supplied to growers is a matter of the most serious importance. It will be remembered that in the case of the American Gooseberry-mildew—this new, extremely destructive and infectious disease which growers are now engaged in fighting in nearly all the fruit-growing counties—the Board were so ignorant of its true nature that on its first outbreak in England and at the most critical period, valuable time was lost before any official action was taken.* At this critical time, instead of supplying authoritative scientific information to growers, the statements were circulated through the country from Kew (the scientific adviser to the Board) that the disease had been known for very many years in England, that it was not a (new) highly destructive, epidemic disease, and that there was no necessity whatever for any legislative measures to deal with it and prevent it spreading through the country.

These statements were allowed to circulate uncorrected by the Board, although the whole weight of scientific opinion was against them. Those who had made a scientific study of the subject knew that as a matter of fact this special mildew was unknown anywhere in Europe before about 1900 (being then introduced from America), and that wherever it had appeared it had spread rapidly and devastated the gooseberry plantations. It is impossible to overestimate the harm that resulted from the circulation through the country of the erroneous statements mentioned above. The opinion then expressed has, of course, since been abandoned by Kew and by the Board. Nevertheless, many fruit-growers, and also persons like Mr. Collinge, who have not specially studied the subject, and yet are ready to give advice to growers, continue to rely † on this statement which had the authority of the Board's scientific adviser, and are still giving erroneous information about the nature and the danger of the disease, and recommending utterly inefficient and uneconomic measures.

Another disease, concerning which the Board have been issuing unscientific information, is that known as the "Warty Disease" or " Black Scab " of potatoes. In their Leaflet (No. 105) the fungus causing the disease was not only wrongly identified, but the statement was made that beet and mangold were liable to be attacked by it, and that therefore these crops must not be sown in soil infested with this potato disease. In view of grave discrepancies in the scientific treatment of the matter (see below, p. 294), and having regard to the serious inconvenience or loss which farmers might experience on this point if compulsory measures were put in force, the Board were asked either to publish the scientific experiments on which the statement in their Leaflet was based, or to withdraw this part of their Leaflet. They are choosing the latter course. During a certain period the Board in England were giving the " scientific " information that " both beet and mangold " are liable to be attacked by this new potato disease ; while the Board in Ireland were stating in their Leaflet No. 91, that " no other crop, apparently, is attacked by this parasite."

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* See *Journal of S.E.A. College*, 1906, p. 312.

† See below, p. 281.

Further, the very same methods of procrastination which characterised the Board when they were confronted with the American Gooseberry-mildew are now again being employed in the case of this new potato disease (see below, p. 301).

With regard to the nature of the scientific measures which have been employed under " The Destructive Insects and Pests Act," information is given below (p. 265). The greatest dissatisfaction has been expressed, also, by growers and by those county authorities which were required to act on behalf of the Board, at the sudden change of policy which took place when the first American Gooseberry-mildew Order was revoked by the Board, and a second Order substituted. Undoubted losses were inflicted on many individual growers by the Board's action. Mr. J. Riley, the President of the Herefordshire Fruit-growers' Association, voiced the feeling at a meeting held last May. Mr. Riley said* :— " The introduction of the American Gooseberry-mildew was a very serious thing. It ought never to have been allowed to come into England. It was known to be in Ireland four years ago, and although he had a long correspondence with the Board, trying to persuade them to prohibit the importation of infected trees, they replied they had no power and took no steps.

* Evesham *Standard*, May 2nd, 1908.

"When the mildew had been imported, however, the Board lost their head, and ordered people to burn their bushes without seeing if they did any harm, and leaving them to the mercy of the county council for compensation. He thought the fruit-growers had just cause for complaint against the Board."

Mr. C. W. Radcliffe Cooke (who, it will be remembered, was one of the members of the Departmental Committee in 1903 on the Fruit Industry of Great Britain), emphasised Mr. Riley's criticism of the conduct of the Board of Agriculture.

Mr. J. W. Willis Bund, Chairman of the Worcestershire County Council, has also complained of the undecided and changeable methods of the Board. Mr. Willis Bund said, * "The result of the Board's policy was that persons who obeyed the law [*i.e.*, the first Order] were now worse off than those who defied it."

The results of the ill-considered action of our Board of Agriculture, attempting as they are to carry out the work without a properly equipped Department, are already proving serious to fruit-growers. In Norfolk, and in other counties, individual growers have been fined heavily for failing to carry out the Board's orders with respect to the pruning of gooseberry bushes affected with the American Gooseberry-mildew. As a matter of fact, however, taking the infected districts generally, the Board are not even seeking to carry out strictly their own measures. As I pointed out in December last,† the amount of pruning required by the Board's Order, *viz.*, "the pruning and destruction of all wood formed in the current or preceding year on the bush" is an operation which is utterly impracticable on a large scale.‡ Consequently, this amount of pruning is now not being required by the Board's Inspectors. Again, the amount of spraying that would be necessary in order to have any effect in checking the spread of so infectious a mildew, *viz.*, a thorough application every ten to fourteen days, (and oftener if rain falls), throughout the summer months, is not being required by either the Local Inspectors or the Board's Inspectors.

* *Birmingham Daily Post*, December, 1907.

† *The Times*, December 23rd, 1907.

‡ In the case of large bushes the cost would be about £4 an acre.

Yet even if the Board's present Order was carried out strictly by all growers, it is certain that this mildew would not be stamped out, because the measures adopted by the Board are not drastic enough (see p. 265). Pruning and spraying alone have failed to stamp out the mildew in other countries. The proceedings at present being taken by the Board against this highly infectious disease are, considered from the scientific standpoint, a farce, although they are beginning to involve heavy demands both on the county rates and on the public purse. The Board are practically giving up the attempt to stamp out this new pest, and are thereby condemning fruit-growers permanently to numerous sprayings, season after season, and eventually to the grubbing of many plantations.

Grave mistakes in other matters, concerning both scientific and practical details, are mentioned below at p. 340.

To sum up the matter. The " Destructive Insects and Pests Act " is a very important *educational* measure. The Board of Agriculture, ill-organised, lacking foresight, with a deficient Intelligence Department, and out of touch with the practical, commercial fruit-grower, are utterly unfitted for carrying out this work. The most essential reform is the immediate creation of " a special Sub-Department of the Board of Agriculture and Fisheries to deal with matters connected with the fruit industry." This reform was asked for unanimously by fruit-growers at the Departmental Inquiry.

I am quite sure that the interests of fruit-growers will not be looked after efficiently until a properly equipped State Fruit or Horticultural Department is created ; and that no more important task for the commercial grower exists than that of pressing forward to secure this reform as soon as possible. I would invite those who are willing to help in this work to join the National Fruit-growers' Federation. Among the main objects of the Federation is that of " urging upon the Government the necessity of putting into force the first Recommendation of the Departmental Committee of the Board of Agriculture on Fruit Growing, namely, ' That a special sub-department of the Board of Agriculture be established to deal with matters connected with the fruit industry.' "

It must be understood that our strictures on the way in which fruit-growers' interests are looked after by the Board of Agriculture are in no sense personal as regards the staff of the Board. We hold strongly that it is the duty of the Government to see that the Board is so equipped that it can properly perform the work the country expects of it. We hold that it should contain a staff of competent men who are both horticultural experts and in touch with the practical industry of fruit-growing, and whose sole business it would be to take such steps as were considered necessary for the preservation of the industry.

In the general work of examining specimens, and also in carrying out experiments, Mr. T. E. Crompton, who has been studying mycology at the College for some time, has given invaluable assistance. A considerable amount of the experimental and spraying work could not have been carried out without Mr. Crompton's help.

To Mr. W. H. Hammond, of Canterbury, I am indebted for numerous photographs illustrating fungus diseases. In the preparation of these a great amount both of skill and of patience has been expended.

The American Gooseberry-mildew*

(*Sphaerotheca mors-uvae* (Schwein.), Berk.).

During the past twelve months, events of considerable importance have happened respecting the measures that have been taken against this newly introduced and most destructive pest of the gooseberry.

Our work primarily has been to try to save fruit-growers in Kent and Surrey from the heavy pecuniary losses which will result if this mildew finds its way into these counties, and is not immediately stamped out. The experience of growers in other countries has shown that when this pest arrives in a country, it inflicts as much, if not more, damage to gooseberries as the " big bud " mite causes to black currants.

For reasons which were stated fully in the last *Journal*, the only hope of dealing effectively with this mildew, and of preventing it spreading through the country, was the employment by the Board of Agriculture of drastic legislative measures. We found the Board of Agriculture totally unprepared for the work, quite ignorant of the scientific aspect of the matter and its economic importance, and strongly inclined to procrastinate. It became our first duty to the growers in Kent and Surrey to agitate until the Board of Agriculture awoke and legislated against the disease on lines similar to those taken in the case of infectious diseases of animals.

This agitation was initiated and carried through by Wye College ; aided, later, very considerably by the National Fruit-growers' Federation, we continued to exert pressure on the Board until finally " The Destructive Insects and Pests Act," became law on July 4th, 1907.

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* A fully illustrated leaflet describing the disease can be obtained on application to the Secretary.

Under this new law the Board have obtained full legislative powers to deal with diseases of plants caused by insects and fungi. The task since has been to endeavour to persuade the Board to carry out their powers under the new Act with energy and on scientific and economic lines.

To make clear the present state of affairs, it is necessary to mention somewhat in detail the steps the Board have taken during the past twelve months.

In July, 1907, the first "Gooseberry Mildew Order" was issued. This order applied to Worcestershire, Gloucestershire, Lincolnshire and Norfolk. Under the Order, the mildew became a notifiable disease (under a penalty not exceeding £10); the Local Authority, on receiving notice of the existence of the disease, was required to make the grower "destroy immediately, by burning or other effective method, all diseased bushes," and then spray with an approved fungicide all the surrounding gooseberry and currant bushes. The payment of any compensation for the bushes compulsorily destroyed was left optional on the part of the Local Authority, which was required to provide the money out of the rates, as no Treasury grant was provided.

I would point out here that these proposed measures were perfectly right and necessary from the scientific point of view, but—as could have been predicted by any Board of Agriculture in touch with practical fruit-growing—were doomed to failure because they were not framed on an equitable basis, so as to secure the co-operation of the grower. It must be remembered that gooseberry bushes only slightly affected with this mildew and not surrounded by diseased plantations, may continue to give a good crop for several years before the mildew shows its full powers; but, during these years, such bushes will constitute a centre of infection, because every summer the mildew will produce on them millions of summer-spores, which will blow about on the wind, and spread the disease through the whole district. The compulsory destruction of slightly diseased bushes in full bearing must therefore be regarded to some extent as the destruction of private property for the public good, and in my opinion some compensation should be paid to the grower. Further, since the matter of stamping out this mildew is one of national importance—for leaving out of consideration the interests of the fruit-farmer, the value of the gooseberry crop to the cottager, private gardener, and jam-maker is incalculable—the Treasury and not the local rates should provide the money for compensation.

It is to be noted that the Board of Agriculture were forced at last to admit the serious nature of the present disease, since in the December number last year of their Journal, it is stated officially that "this disease has rendered the cultivation of gooseberries unprofitable wherever it has appeared, and in some cases even impossible."

The actual course of events following the issue of the first Order in July was as follows. In Worcestershire (Evesham) and Norfolk (Wisbech district), where there are some hundreds of acres of diseased bushes, the County Council sent out notices ordering the destruction of diseased bushes, and at the same time intimated that no compensation would be given. But the destruction of the bushes never took place; in the absence of compensation no systematic destruction of diseased bushes over the infected areas was found possible. The growers protested, and both the County Council and the Board of Agriculture feared to exert the necessary legal pressure in face of the protest. The deadlock continued through the summer months,—during which time, of course, the mildew considerably enlarged the areas of infection.

In October last, in a letter to the *Times*, I wrote as follows:—

"When urged repeatedly last year to bring in an emergency Bill giving them powers to deal with the newly-introduced and highly destructive fruit pest known as the American Gooseberry Mildew, the Government temporised, and thereby lost the opportunity of dealing with the disease at the most effective time—that is, while it was dormant and before it had begun to spread by means of its summer-spores.

"Since then, their eyes having been opened by the very rapid spread of the disease and by the serious economic interests involved, they have seen the danger of further delay, and on July 4th the Destructive Insects and Pests Act became law. The mildew was then actively spreading, and the Board hastened to issue an Order to enforce the compulsory destruction of diseased bushes. But, owing to the provisions of the Act, the payment of compensation was left optional on the part of the county council, no Treasury grant being available. This Order nominally came into operation on July 22nd last, yet up to the present time no systematic compulsory destruction of diseased bushes over the affected areas has occurred.

During the past months the mildew, as any mycologist could have predicted with certainty, has spread to an alarming extent. It is probable that in Worcestershire alone there is now twice the amount of disease,—and consequently double the number of bushes to be destroyed,—that there was last winter.

"From the first we have urged that compensation should be paid from Treasury funds for the compulsory destruction of bushes. The county councils have feared to carry out the provisions of the Order without paying compensation, and have feared equally to lay this burden on the rates; the Board of Agriculture have apparently been afraid of forcing the county councils to take the thorough measures necessary to stamp out the disease. The obvious injustice of not giving compensation has paralysed action, and the Board of Agriculture, without any competent scientific leadership, have again temporised at the most critical stage.

"There is now but one opportunity remaining of dealing with the American Gooseberry Mildew and preventing it sweeping through the country, and that is to deal with the disease this winter, but it must be by thorough and uncompromising measures. The mildew is now known in some six counties; in each one it is essential that it should be eradicated before next spring.

"Some compensation must be given from Treasury funds. It will be money well spent to protect the interests of fruit-growing, one of the most economically important branches of agriculture. The average annual value of the gooseberry crop in Kent, Wisbech, Evesham and Gloucestershire is from £97,000 to £160,000."

Under the first Order, then, drastic and scientific measures were proposed, which, however, were never carried out, owing to the opposition of fruit-growers, due to the non-payment of any compensation.

The drafting of this first Order—as regards the scientific details—was the work of what may be called the Reform party at the Board of Agriculture ; it became now the turn of what may be called the Reactionary party at the Board. A complete change of policy was announced, and the drastic, scientific measures of the first Order were replaced by the mild, unscientific and impracticable measures of the second Order.

The last efforts of the Reform party can be seen in the article published in November last in the *Journal of the Board of Agriculture*, which gave the results of the attempts of the Worcestershire County Council, during the summer of 1907, to deal with the disease by spraying. We read as follows : " The result of spraying as a means of checking the disease may be described as not altogether satisfactory. Not only have bushes previously affected been attacked again in spite of all precautions, but bushes which last winter were believed to be free from disease have become affected in spite of careful pruning, followed by regular spraying. It is clear that even pruning and spraying will not ensure immunity from the disease, and, apart from the requirements of the law, growers would surely not prefer to prune their bushes hard, to spray six or seven times, and then get a crop tainted with disease, when by destroying totally and immediately all diseased bushes, they can extirpate a pest which has but newly arrived,* and has not yet shown its full power for evil."

This was published in November ; but about this time the President of the Board of Agriculture began to receive deputations of growers from Wisbech and Evesham. These deputations urged that some compensation should be given if the compulsory destruction of bushes was to be carried out under the provisions of the first Order ; and if no compensation was to be given, they asked that the first Order should be revoked, and a second Order issued allowing pruning and spraying to be substituted for the destruction of diseased bushes. This change of policy—disastrous from the scientific standpoint, but involving no payment of compensation—suited the views of the Reactionary party at the Board, and on December 10th last, the second Gooseberry Mildew Order was issued. Under this Order, which is still in force, the following measures are proposed: the Local Authority on receiving notice of the existence of the disease is required to make the grower take the following steps; in summer, to spray the diseased bushes and those surrounding them with an approved fungicide; in winter, to destroy by burning or other effective method either the whole bush, or *if he so prefer, all wood formed in the current or preceding year on the bush*—the clippings or prunings to be destroyed.

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* The American Gooseberry Mildew was unknown in Europe before 1900.

I wrote at the time as follows:—" It is obvious, I think, that now he is given the alternative of pruning and spraying, no grower will grub up and burn diseased bushes; indeed, to speak candidly, he would be extremely foolish to do so if meanwhile his neighbours are permitted to employ the experimental measures of pruning and spraying in surrounding plantations. Practical growers will realise, too, the absurdity of supposing that a grower will be able to prune off and burn the whole of the young wood of the bushes in an affected plantation without suffering heavy pecuniary loss.*

" So matters stand at present. I would suggest that now, while the Board and fruit-growers are faced with the sight of some hundreds of acres of diseased plantations (still fortunately strictly localised in quite a few counties) they pause a moment and call to mind the measures that were taken against rabies, the one animal disease which has been successfully stamped out. This disease was stamped out because the scientific plan of campaign, which involved the proper muzzling of dogs, was never allowed to be changed to embrace milder measures. The Board had a leader then. It may well be that in years to come fruit-growers will remember the winter of 1907-8 as the time when the " muzzle " was taken off the American Gooseberry Mildew, the Board lacking a leader to insist on scientific principles, and preferring to permit mild measures to be employed rather than to work out a scheme of compensation under which the absolute destruction of diseased bushes would be ensured.

" Is it too late? We have this dangerous disease now dormant on the bushes and unable to spread an inch before next May; then it will begin to spread by summer-spores carrying the disease far and wide. It will affect the prosperity of a crop of the annual value in Kent, Wisbech, Evesham, and Gloucestershire alone of

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* The cutting out of the whole of the young wood and the collecting and burning of it would cost about £4 per acre.

£97,000 to £160,000. In the absence of an agricultural party in the House of Commons, and of a united association of fruit-growers, there is no voice powerful enough, apparently, to obtain from the Treasury the compensation grant which is required in order to carry out the necessary scientific measures to stamp out the disease."

In a letter to *The Times*, published on December 23rd last, I criticised the second Order as follows :—" During the past months the determination of the Board to carry out their original policy has broken down before deputations of growers, demanding either that some compensation should be paid, or that the Order for the destruction of bushes should be revoked.

" It must be remembered that the Board before issuing their first Order were fully convinced of the necessity for the absolute destruction of diseased bushes as the only scientific way to stamp out the pest, and that the evidence in their possession had convinced them that any half-measures, such as pruning and spraying, would be ineffectual.*

" On December 10th, a new Order was issued, revoking the previous one. This new Order permits pruning and spraying as an alternative to destroying the diseased bushes. The policy is unscientific, uneconomic and ridiculous.

" It is unscientific because, as a matter of fact, the whole weight of scientific evidence goes to show that pruning and spraying are insufficient to stamp out this pest.

" It is uneconomic since, at the most, spraying will only keep the disease in check at a prohibitive cost. In the United States the continual sprayings necessary to protect the European varieties of gooseberries against this mildew, have been found so expensive as to make the commercial cultivation of our gooseberry unprofitable. The pruning and destruction, as ordered, of ' all wood formed in the current or preceeding year on the bush ' is an operation which, even if not utterly impracticable on a large scale, is far too costly.

" It is ridiculous, because as an alternative measure it is less efficacious while being quite as unworkable in the absence of compensation.

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* See *e.g.*, Prof. J. Eriksson's evidence given in his accounts of the rapid and persistent spread of the disease in Sweden.

"No Act was more needed to protect the interests of the fruit-grower than the 'Destructive Insects and Pests Act,' passed last July; but no greater proof of the inefficiency of the Board in dealing with matters concerning practical fruit-growing could have been given than the short-sighted and wavering measures they have employed against the first epidemic plant disease with which they have attempted to deal. And no greater proof could have been given of the necessity that exists for securing that reform asked for by fruit-growers in 1905, viz., the creation of a special sub-department of the Board of Agriculture to deal with matters connected with the fruit industry."

On January 18th last, I read a paper before the Canterbury Farmers' Club and East Kent Chamber of Agriculture in which, after pointing out the above facts, I continued as follows:—

"One very important point remains to be considered;—what steps should counties, like Kent, where the disease is still unknown, now take?

"I am convinced from my experience during the past two years that the Board of Agriculture as at present organised—that is, without any special sub-department to deal with matters connected with the fruit industry—are quite incapable of looking ahead to take the necessary steps to protect growers from new epidemic fruit pests such as the American Gooseberry Mildew. The present Board have neither the time nor the necessary knowledge.

"I would warn you that unless you, and the fruit-growers of Kent generally, put strong pressure on the Board, and see that the proper steps are taken to stamp out the American Gooseberry Mildew in the affected counties, you will find that this pest will creep down into Kent, and then you will have the same trouble and the same losses in your gooseberry plantations as you have now in black currant plantations through the 'big bud' disease.

"If I may be allowed to make a proposal, I would suggest that this Club unites with the other Farmers' Clubs and Fruit-growers' Associations in Kent, to send a strong and representative deputation to the Board of Agriculture. Unsound as the measures of the second Order are, and playing with danger as it is to allow yet another winter to pass without securing the complete destruction of the affected plantations, the Board will probably now insist on time being given to test their new policy; but a strong deputation from Kent ought to be able to extract a promise from Lord Carrington that if the American Gooseberry Mildew appears next summer to any extent in the affected districts, in spite of the pruning that has been done, the Board will cease experimenting, and secure the immediate compulsory destruction of diseased bushes by the payment of some compensation from Treasury Funds.

"In the meantime the County Council should decide what plan of action it will adopt if an outbreak of the American Gooseberry Mildew occurs in Kent.

"I am opinion that, until English fruit-growers are able, by proper co-operation and organisation, to obtain from the Board of Agriculture a scheme of compensation paid out of a Treasury grant, it will be for the best interests of such fruit-growing counties as Kent that some compensation should be paid out of the rates, *so as to ensure that the first cases of disease in the county are promptly stamped out by the total destruction of all affected bushes.* Owing to the present policy of the Board, however, there may be some difficulty here. Directly an outbreak in Kent is reported, the Board will extend the present Gooseberry Mildew Order to include Kent. Under this Order any grower in Kent will be allowed, as an alternative to destroying his diseased bushes, merely to prune and spray them. Although, no doubt, if compensation were given by the Kent County Council, growers in the county, as a whole, would consent to the burning of diseased bushes, it is quite possible that a grower here and there would claim the right, under the Order, merely to prune and spray,—and the Kent County Council would then be helpless in the matter.

"All preparations for the plan of campaign ought to be made beforehand, and I think that the Kent County Council would do well to ask the Board of Agriculture to promise that, in the event of an outbreak in Kent, they will issue an Order to apply to this county, which shall require the grower to destroy, at once, the diseased bushes, and not allow him any alternative.

"If the Board refuse to issue such an Order, then the spread of the mildew in Kent, which will in all probability take place if the experimental measures of pruning and spraying are allowed, will justly be regarded as the outcome of the unscientific and uneconomic policy of the Board.

" Wye College, of course, will do all that is possible to detect and stamp out the first outbreaks of the mildew in the county, but I am anxious to point out that if this new disease spreads through the county, and inflicts severe losses on the owners of gooseberry plantations, the College cannot be held in any way responsible, because the advice it has persistently given as to the method of dealing with this disease has not been taken by the Board of Agriculture."

The Canterbury Farmers' Club resolved unanimously to ask other Farmers' Clubs in Kent to join with them in sending a Deputation to the Board of Agriculture. On April 8th, Lord Carrington received at the Board of Agriculture a Deputation composed of the following delegates :—Mr. J. D. Maxted (Chairman), and Messrs. G. Mount, W. W. Berry, and E. S. Salmon, of the Canterbury Farmers' Club ; Messrs. G. E. Champion, B. Champion, and T. Edmunds, of the Maidstone Farmers' Club ; and Messrs. H. Chapman and S. Lee, of the West Kent Farmers' Club.

Mr. Maxted, in introducing the Deputation, remarked on the seriousness of the possible introduction of the mildew into Kent, and on the large financial interests at stake in the county.

Mr. E. S. Salmon made the following statement as representing the opinions of the delegates :—

" Since the appearance in England of the American Gooseberry Mildew the outlook for owners of gooseberry plantations in Kent has been one of considerable anxiety. The heavy losses incurred in Kent through the ravages of the pest of black currants known as the ' big bud ' mite have made fruit-growers most anxious that every possible step should be taken to save the gooseberry crop from any similar damage. The American Gooseberry Mildew is a pest which, to quote the Board of Agriculture's own words, ' has rendered the cultivation of gooseberries unprofitable wherever it has appeared, and in some cases even impossible.'

" Kent is believed to be, at present, free from the disease, the single outbreak which was discovered in a nursery in November, 1906, having been stamped out at once by the owner destroying the entire stock of affected bushes, on the advice of Wye College.

" We feel strongly that, considering the annual value of the gooseberry crop to nearly all classes in the county, it would be a suicidal policy not to take every possible step to stamp out the disease at once if it should appear in the gooseberry plantations in Kent. We strongly desire that any outbreak in Kent should be dealt with at once by the compulsory destruction of all diseased bushes.

" At the last meeting of the Kent County Council, a resolution was passed unanimously that an application should be made to the Board of Agriculture for an Order (to be issued now) to empower the Council, in the event of any outbreak, to order the grower to destroy immediately the diseased bushes, and not to allow the grower the alternative of pruning, as at present permitted by the Board's Orders issued to affected counties.

" The Kent County Council passed a further resolution that in all cases of compulsory destruction of diseased bushes, the grower shall receive some compensation,—this compensation to be paid out of the rates only if it cannot be obtained from the Board of Agriculture.

" We strongly support the action taken by the Kent County Council, and earnestly ask for such an Order, so that every step may be taken beforehand in order to be able to deal summarily with the mildew if it makes its appearance. We urge especially that the burden of compensation should not be laid on the rates, and would point out that the proposal to do so (in the case of any outbreak) is already meeting with considerable opposition. We respectfully urge the justice of the claim, put forward by Lord Harris at the meeting of the Kent County Council, that as the Board of Agriculture pay compensation to the stockowner for the slaughter of stock suffering from certain diseases, it is only right that the fruit-grower should be compensated from the same source. We would point out that, under the ' Destructive Insects Act ' of 1877, compensation has in the past been paid by the Treasury in cases of the compulsory destruction of potatoes affected with the Colorado Beetle.

" Secondly, we recognise the importance of the fact that if this mildew is not completely stamped out in the various counties already affected, it will only be a matter of time before the pest finds its way to Kent (and to the other counties at present free) in increasing quantity.

" We regard it as a matter of paramount importance for all counties at present free from the mildew that the most drastic measures should be employed in all the affected areas to stamp out the disease. We look upon the question as one of national importance, as the interests of every county are concerned. We submit that there is no scientific evidence that the measures of pruning and spraying at present permitted by the Board's Orders are sufficient to stamp out such an infectious and epidemic disease as the American Gooseberry Mildew has proved itself to be in the United States, and since 1900, in Ireland and on the Continent. We would call attention to the following statement published in the *Journal of the Board of Agriculture* for November last :—'Not only have bushes previously affected been attacked again in spite of all precautions, but bushes which last winter were believed to be free from disease have become affected in spite of careful pruning, followed by regular spraying. It is clear that even pruning and spraying will not ensure immunity from the disease.' We urge therefore, the employment of the drastic measures, involving the immediate destruction of all diseased bushes, which were embodied in the first Order issued by the Board, but which in the absence of any compulsory scheme of compensation, were found to be impossible to be carried out.

" But, while asking for more drastic measures to be taken in affected counties, we are most anxious to state that we do not consider it equitable, or indeed possible, for such measures to be carried out without the payment of compensation. We are of the opinion that it is not equitable either that the compensation should be paid out of the rates, and we are convinced that, taking the counties of England as a whole, the drastic measures necessary for the stamping out of this mildew, can be enforced uniformly only if compensation is given by the Board of Agriculture.

" We earnestly ask, therefore, for an assurance that if the American Gooseberry Mildew shows itself to any considerable extent this summer, in the affected plantations in the various counties, in spite of the compulsoyr pruning and spraying which have been carried out under the Board's present Order, the Board of Agriculture will substitute the original Order requiring the total destruction of all diseased bushes,—the necessary compensation to be paid by the Board and not out of the rates."

Mr. W. W. Berry then laid stress on the importance of the matter from the labour standpoint. Taking the acreage of gooseberries in Kent as 6,000 acres, Mr. Berry pointed out that the wages' bill would be not less than £60,000 annually, and he asked whether it was not worth while to spend a little money, in the giving of compensation, in order to preserve so important a crop to the county.

Other members of the Deputation spoke of the importance of gooseberry growing to the small holder, whose plantation often represented a considerable part of his capital, and which could not be destroyed if it became diseased, without the payment of some compensation.

Lord Carrington received the Deputation sympathetically and expressed the desire to do all he could to keep Kent free from the disease. The payment of compensation from Treasury funds was not at present possible, but the whole matter was at present under consideration. If the measures adopted should prove, during the course of the summer, to have been ineffectual to stop the disease from spreading in the various affected counties the Board would be prepared to take more drastic steps.*

The two following extracts from the local press show the steps that have been taken by the Kent County Council. The first relates to a meeting of the Council held in February last; the second to one held in May.

"Councillor Amos moved, in accordance with notice: 'That this Council requests the Board of Agriculture to issue an order at once authorising it to compel any grower to destroy any bush growing in Kent on which the American Gooseberry Mildew is found. That inasmuch as the county of Kent is now free from the American Gooseberry Mildew, this Council delegates its powers to deal with any outbreak that may occur in the county to the Diseases of Animals Committee, to enforce the provisions of the Order of the Board of Agriculture and to compensate out of the rates (unless the Board of Agriculture otherwise provides the compensation) any grower whose bushes have to be destroyed.' It was a question, Councillor Amos said, of shutting the door and keeping the thief out. Where the disease was established it was doing tremendous harm, and it was desirable to keep the county free from it. He agreed that it was a great deal better that the Board of Agriculture should pay the compensation, but if it could not be got from the Board of Agriculture they should get it from the rates. The first cost would be very trifling if an outbreak was promptly dealt with.

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* The substance of the above appeared in *The Times*, April 15th, 1908.

"Alderman Sir William Hart-Dyke seconded. The matter, he considered, was one of very great importance and he thought the Council should place every temptation in the way of growers to take immediate steps to deal with and destroy any outbreak which might occur.

"Alderman Lord Harris supported the motion, but expressed the hope that the Council would bring pressure to bear upon the Board of Agriculture for compensation to be paid out of taxation and not out of the rates. The Board of Agriculture paid compensation in the case of the big stockowner, for the slaughter of stock suffering from certain diseases, and he thought it only right that the small fruit-grower should be compensated from the same source, when his stock of plants had to be destroyed.

"Councillor Brown (Whitstable) also supported the motion, but hoped the Committee would frame regulations in order that there might be no abuse of the grant.

"Councillor Quested (Cheriton) thought the Council should be very careful in dealing with the matter, and reminded them that no compensation was paid for slaughter of cattle suffering from anthrax. He also drew attention to the danger of infection from neighbouring counties unless regulations were made generally, and he thought the matter one which should be dealt with by the Board of Agriculture. At any rate steps should be taken to induce Sussex and Surrey to fall into line.

"Councillor Brice considered the matter should be fully gone into by the Committee and reported upon before decision.

"Councillor Rice (Eastry) considered the matter one of extreme importance. He was informed that under the present Order growers were only compelled to prune the diseased twigs, which he was told was an inefficient remedy. The only way to deal with the disease properly, he understood, was by burning.

"Alderman Waring thought that what was done should be done at once, especially in the interest of the small growers, and Councillor Vinson (Swanley) agreed.

"The motion was then put and carried *nem. con.*

"It was also agreed, at the suggestion of Alderman Cornwallis, that the Chairman of the Committee should submit regulations to the next meeting, and that he should also approach the counties of Surrey and Sussex,* with a view to getting them to act upon similar lines."†

The following report of the next meeting of the Council appeared in the press :‡

"Resolutions had been received from the Boards of Guardians of the Canterbury, East Ashford, Faversham, Hollingbourne, Hoo, Medway, Tenterden, and Thanet Unions protesting against 'the County Council charging the cost of endeavouring to stamp out Gooseberry Mildew, together with compensation to growers, on the already heavy and increasing local rates, believing that in so small an area as a county no permanent benefit would result, but that if the disease is considered of sufficient importance for action to be taken such action should apply to the United Kingdom, be directed by the Board of Agriculture, and compensation, if necessary, paid out of imperial funds, and not out of local rates.'

"The Council, at its meeting in February last, passed a resolution requesting the Board of Agriculture to issue an order to compel any grower to destroy any bush growing in Kent on which the American Gooseberry Mildew is found, and that compensation be paid out of the rates (unless the Board of Agriculture otherwise provides the compensation) to any grower whose bushes have to be destroyed.

"The Diseases of Animals Committee reported that no reply had as yet been received from the Board.

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* At the suggestion of Wye College, the county of Essex was added to the list.

† *Kentish Express*, February 22nd, 1908.

‡ *Kent County Examiner*, May 22nd 1908.

" Mr. Cornwallis, in proposing the adoption of this Committee's report, said that he thought the Boards of Guardians which had forwarded the above resolution scarcely realised the object the County Council had in view. The idea was that the decision to spend a small sum in compensation would act as an inducement to growers to give notice of the disease as soon as it appeared, and thus avert a calamity to the fruit-growing industry. The Council agreed that the cost ought to come from the national exchequer, but as this was impossible at present, it was thought wise to spend a small amount from the county.

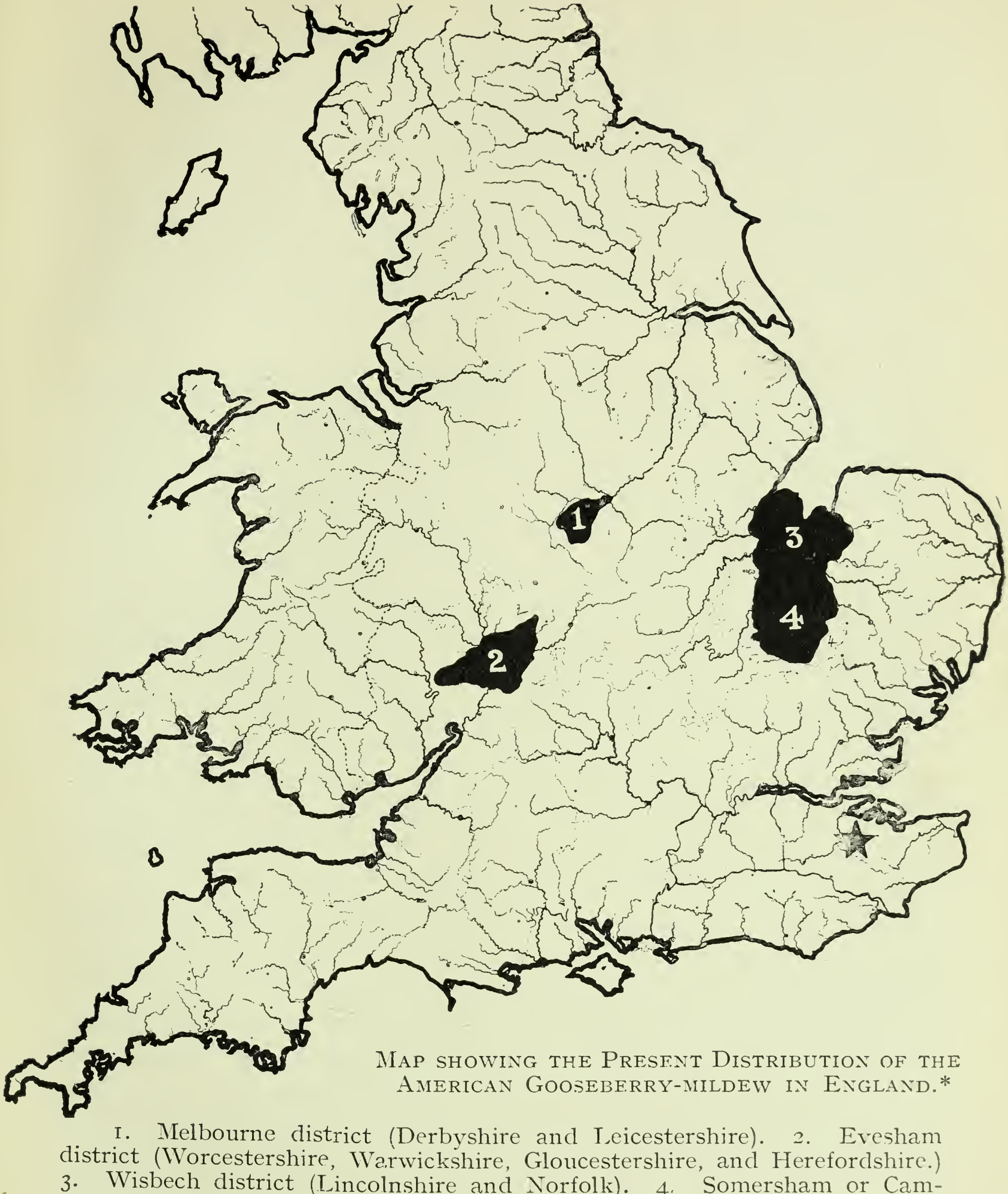
" The Clerk now read a letter from the Board of Agriculture, consenting to strengthen or modify the existing Order on the subject, but intimating that there was no likelihood of compensation money being paid from imperial funds.

" On the motion of Mr. Cornwallis, seconded by Mr. Laurie, this communication was referred to the Committee."

At present, then, the matter is left in the hands of the Committee appointed to deal with Diseases of Animals. It is sincerely to be hoped that this Committee will strongly advise the Kent County Council to take a vigorous line of action. Considering the financial interests at stake in the county, Kent should be in the van of the fruit-growing counties of England in insisting that the proper scientific and economic steps are taken by the Board of Agriculture to prevent the American Gooseberry Mildew from spreading through England ; and, especially, in taking every step to make certain that the pest is stamped out in Kent if an outbreak should occur.

Let us consider the present distribution of the Mildew in England. The map on p. 275 shows that the disease is, at present, strictly localised, the affected areas being as follows :—(1) Melbourne district (Derbyshire and Leicestershire) ; (2) Evesham district (Worcestershire, Warwickshire, Gloucestershire, and Herefordshire) ; (3) Wisbech district (Lincolnshire and Norfolk) ; (4) Somersham or Cambridge district (Cambridgeshire and Huntingdonshire).

I hope that all growers of gooseberries who look at this map will realise that a critical stage in the fight against the mildew has now been reached. The action taken by the Board of Agriculture during



Map showing the Present Distribution of the American Gooseberry-mildew in England.*

1. Melbourne district (Derbyshire and Leicestershire). 2. Evesham district (Worcestershire, Warwickshire, Gloucestershire, and Herefordshire.) 3. Wisbech district (Lincolnshire and Norfolk). 4. Somersham or Cambridge district (Cambridgeshire and Huntingdonshire).

★ Kent (outbreak in 1906 on Standard Gooseberries in a nursery ; *now stamped out.*

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* While the present article was in the press, very serious outbreaks, affecting several hundred acres, have been discovered in Kent. The full extent and history of the outbreaks and the measures taken in Kent against the disease, will be described in detail in the next number of this *Journal*.

the next year or so will decide whether this mildew is to be stamped out or whether it is to be allowed to establish itself permanently in this country, in which case one more serious pest will be added to the list of those which inflict losses on the grower year after year.

At present, as the map shows, *this mildew is strictly localised*, but so long as the disease is not stamped out in the affected areas, Kent* and Surrey (and all those counties at present free) remain exposed to the constant danger of the disease invading their boundaries.

The mildew has been found once in Kent.* This was in November, 1906, when I found a number of affected standard gooseberries (recently imported from the Continent) in a nursery. Through the good sense of the owner, the whole of this stock was immediately grubbed up and burnt. To all appearance the disease was thus stamped out. This was before any legislative measures existed against the disease. Now if an outbreak occurs in Kent, the owner will be permitted, under the Board's second Order, the alternative of pruning and spraying the diseased bushes. That is to say, measures which have proved valueless against this disease in other countries, have now received the sanction of the Board of Agriculture for use in England. In the present state of affairs, therefore, the interests of fruit growers in Kent are more likely to receive injury than benefit from the way in which the "Destructive Insects and Pests Act" is being administered.

The following facts demand the earnest attention of fruit growers in Kent.

The information recently obtained, by means of Questions asked in the House of Commons by Mr. Laurence Hardy, shows that *the measures now being taken by the Board are not stamping out the disease in the affected areas*. In answer to the Question "as to the total number of outbreaks of American Gooseberry Mildew in the summer stage that have occurred this summer; and whether these outbreaks have occurred in plantations where the instructions of the Board as regards pruning in winter have been carried out," the Board replied on June 25th, as follows: "Seventy outbreaks of American Gooseberry Mildew in the summer stage have occurred this year in the following counties, *viz.*, Herefordshire (2), Warwickshire (4), Norfolk (10), Isle of Ely (7), Worcestershire (13), and Huntingdonshire (34). With the exception of one outbreak in Herefordshire, and another in Warwickshire, all the cases have occurred in plantations where the disease appeared last year. They are probably due to imperfect pruning. We may add that fruit growers are now willingly complying with the requirements of our Orders, and are taking all necessary steps to get rid of the disease."

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* See footnote, page 275.

Two points are to be noted in this answer. First, that the Board suggest that the reappearance of the disease in the infectious summer-stage, in plantations which were known to be diseased last winter, is due to "imperfect pruning"; secondly, that they assert that *growers by complying with the present Orders are taking all necessary steps to get rid of the disease.*

Now, if the reappearance of the disease is attributable to "imperfect pruning," it is obvious that, either the sixty-eight plantations now affected ought not to have been passed by the Board's Inspectors as properly pruned according to the requirements of the Order, or that this Order which requires the grower to go over all the affected bushes and cut off and burn "all wood formed in the current or preceding year on the bush," is impracticable, since it cannot be carried out even under the eye of an Inspector.

In order to obtain further information, Mr. Laurence Hardy asked the following question: "Whether, in the sixty-eight recent outbreaks of the American Gooseberry Mildew in the summer stage reported to the House of Commons by the Board on June 25th last, and attributed by them as probably due to 'imperfect pruning,' the plantations in which the outbreaks have occurred had been passed by the Board's Inspector as properly pruned according to the requirements of the Board's Order." The Board replied (on July 1st) as follows:—"The plantations to which the Hon. Member refers were, with one exception, to all appearances pruned as required by the Board's Order, and their Inspectors reported that no further visits were necessary before the summer. The Board recognise that disease is likely to recur in certain cases, and therefore provided in their American Gooseberry Mildew Order of 1907 that no infected premises should be freed for twelve months after disease last appeared there, so long as any bushes remain on the premises. The plantations will, of course, be kept under observation during that time."

The facts disclosed show a very serious state of affairs. At the beginning of the first summer, after the new Order has been in force, the mildew has broken out afresh in seventy plantations, and in no less than sixty-seven of these the requirements of the Order as regards pruning had been carried out to the satisfaction of the Board's Inspector. Yet the Board, with the fatuity that characterised their action at the time when the disease was first recorded for England in 1906, now state publicly that "fruit-growers are taking all necessary steps to get rid of the disease." They mention that the infected plantations will not be "freed" for twelve months after the disease last appeared, as though the mere keeping of these diseased plantations under observation were a matter of real importance in the stamping out of the mildew. The gravity of the matter is, of course, that during the summer there will be—in spite of the occasional spraying that will be required to be done under the Order—the constant danger, or rather the certainty, of the disease spreading to surrounding plantations, through the production by the mildew of myriads of summer spores.

A third and final question on the subject was asked by Mr. Laurence Hardy, as follows: "Whether, having regard to the fact that the Board of Agriculture have stated in their Memorandum on the subject that the American Gooseberry Mildew is a disease which 'has rendered the cultivation of gooseberries unprofitable wherever it has appeared, and in some cases even impossible,' and, further, that this mildew has now broken out afresh in the highly infectious condition known as the summer-stage in sixty-seven plantations, in which the bushes had been pruned according to the Board's Order and to the satisfaction of the Board's Inspectors, the Board of Agriculture will now have recourse to more drastic measures to ensure the stamping out of this pest, according to the promise made by the President of the Board of Agriculture to the Deputation of fruit-growers from Kent on April 8th last." The Board replied as follows: "The experience gained in dealing with American Gooseberry

Mildew this year goes to show that it will not be desirable at any rate, at present, to alter the Order now in operation."

The matter must not be allowed to rest here. We must press for a full account of the nature of the " experience " that has been gained by the Board ; to be satisfactory it must be of the very opposite character to that disclosed in the Board's previous answers. We must press for the publication of detailed returns, dealing with the American Gooseberry Mildew, under the " Destructive Insects and Pests Act," similar to those which are regularly published dealing with Swine Fever, Anthrax, Glanders, and Sheep Scab, under the Diseases of Animals Acts. Although the first steps under the Destructive Insects and Pests Acts were taken in July, 1907, a year has already passed without any official information having been published, as to the acreage of gooseberry plantations which are affected, and as to the results which have been obtained under the two Orders which have been put in force.

In a paper read during last May to the " Farmer's Club " in London, I quoted a number of cases in which the Board of Agriculture, in the measures they have advised growers to take against the American Gooseberry Mildew, have shown marked incompetency in dealing with scientific and practical matters of great importance to fruit-growers.*

A needless expenditure by growers of considerable sums of money has been one of the indirect results of the Board's advice on one point.

It is worth while looking into this matter somewhat closely, because it affords a clear case of one of the many ways in which growers, at the present time, are being misled by pseudo-scientific advice, in the absence of a Department at the Board of Agriculture properly equipped for the work of plant pathology, and able to take a strong scientific lead, and to speak authoritatively.

At the time of the first outbreak of the mildew in England I pointed out that spraying could not be relied upon, even to keep in check this infectious and epidemic disease, much less to stamp it out. I obtained the opinions of two scientists who were pre-eminently fitted to give expert evidence on the point. Prof. S. A. Beach, who is one of the highest authorities in the States on the commercial cultivation of gooseberries, and who has had many years' experience of the ravages of the mildew, made the following statement: "Under conditions which were most favourable to the development of the disease, it has been found that it is extremely difficult to hold it under control by spraying, but under favourable cultural conditions, and in favourable seasons, the disease can be held well under control. In order to insure crops of fruit free from disease, as they must be if the business of gooseberry culture is to be placed on a reliable commercial basis, *it has been found necessary to begin the treatment early in the season, and to spray at intervals of from seven to ten days, always making the applications very thoroughly.* The expense of such treatment is so great as to discourage the commercial growers, as is evidenced by the fact that, although it is nearly thirty years since a reliable remedy for the mildew was discovered, the English gooseberries are not being cultivated commercially to any considerable extent in America." Prof. Eriksson, who is one of the leading mycologists of Europe, and who has been for several years in charge of the operations taken in Sweden by the Government against this mildew, wrote as follows: "Neither spraying with fungicides, nor cutting off the infected shoots, nor cutting off the branches down to the very ground, stopped the spread of the disease."

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* See page 340.

It was obvious, therefore, that if the Board intended to set to work first to stop this mildew from spreading, and then to eradicate it (and unless the eradication of this new disease was aimed at legislative measures were out of place) more drastic measures than spraying and pruning were required. All this evidence was placed in detail before the Board.

The Board then issued its first Order, requiring the owner to destroy all infected bushes. The Board discovered that they could not carry out this Order unless they paid some compensation for the compulsory destruction of bushes. For some months the Board remained irresolute.

During the time when the growers in Worcestershire were objecting to the destruction of bushes without the payment of compensation, Mr. W. E. Collinge (then at Birmingham University) began to express the view, both publicly and to growers, that spraying was a perfectly satisfactory way of dealing with this new epidemic and highly infectious disease.

About this time, too, a proprietary winter-spray fluid began to be advertised as " the only certain remedy for American Gooseberry Mildew." It is only necessary to say that, as no winter wash is known that will kill the mildew in its winter-stage, those growers who were induced to spray in winter literally wasted their money.

Then the Board, putting aside all scientific evidence, issued their second Order, permitting pruning and spraying. This official approval of spraying had, of course, the immediate effect of opening the gates for a host of proprietary washes on which growers could be enticed to waste their money.

On the appearance of this Order I pointed out* that the whole weight of scientific evidence showed the futility of the Board's new measures, and that only the complete destruction of diseased bushes would stamp out this disease and prevent it spreading through England. Mr. Collinge then wrote to *The Times* as follows :—

" Whilst having no desire to interfere with the harmless amusement indulged in by your correspondent, Mr. E. S. Salmon, I do desire to state that, so far as a very large and growing number of fruit-growers of this country are concerned, they are totally adverse to the action he advocates, and do not believe in the hysterical views he has so frequently set forth in the Press.

" The majority of fruit-growers in this country are of opinion that the American Gooseberry Mildew has been in this country for at least thirty years, if indeed it is not indigenous, and that the harm it has done is comparatively trifling. That it can easily and effectively be controlled I have shown by actual experiment. Pruning and spraying are quite sufficient and practical.

" Whilst fully appreciating the value of such a measure as the ' Destructive Insects and Pests Act,' I deprecate most strongly the wild statements made by Mr. Salmon and the agitation he initiated, which were largely responsible for the issue of the stringent and ineffective Orders recently (and wisely) revoked. The statement that ' the gooseberry growers of this country are, in all probability, about to suffer the loss of hundreds of thousands of pounds in the next few years ' is, in my opinion, one that has nothing to support it except the imagination of the writer, who, whilst others have been endeavouring to find an effective remedy, has been content to paint in vivid colours the manner in which, in his opinion, this disease would run rampant throughout the country and the terrible losses that would consequently ensue, but which fortunately has not yet proved to be the case. In my opinion, and that of very many others, it is quite time that such hysterical nonsense ceased."

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* *The Times*, December 23rd, 1907.

I replied as follows :—*

"In Mr. W. E. Collinge's letter on the above subject, published in *The Times* last Monday, there are two statements concerning points of scientific interest.

"The first is that 'the majority of fruit-growers in this country are of opinion that the American Gooseberry Mildew has been in this country for at least thirty years, if indeed it is not indigenous, and that the harm it has done is comparatively trifling.'

"The second is that he has shown 'by actual experiment that this disease 'can easily and effectively be controlled.'

"In reply to the first statement, as I cannot repeat here the scientific evidence which shows conclusively that the American Gooseberry Mildew was unknown in Europe before 1900, I must refer Mr. Collinge to *The Times* of December 28th, 1906, and January 10th, 1907, and to the *Journal of the South-Eastern Agricultural College*, vol. XVI., p. 299. It is certain that fruit-growers in this country have had, hitherto, no experience of this new destructive pest. The fact of the recent introduction of this mildew from America into Europe is well known to mycologists; it is now admitted by the Board of Agriculture, since one of their inspectors, speaking to fruit growers, at Wisbech last week, is reported as having said:—'This [mildew] was certainly not a complaint they had had for forty years, and whenever a man told them that, he was a man who had been ill-informed as to this disease.' Mr. Collinge is an entomologist; he is either ignorant of the main facts concerning this new fungus disease, or, more probably, he is unable to comprehend adequately mycological matters.

"With regard to the second statement, Mr. Collinge must learn that a mycologist, before he can expect such a statement to be believed, must publish the full scientific details of his work. It is obvious that until this is done, such statements can have no more scientific value than the advertisements of patent medicines or patent spray-fluids. Mr. Collinge, not being a mycologist, is on strange ground, and seems anxious to sustain his confidence by leaning on the support of 'a growing number of fruit-growers,' apparently not realising that he is dealing with points on which only the specialist possesses the requisite scientific knowledge."

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* *The Times*, January, 1908.

During the spring various washes were put on the market and offered to growers as certain remedies against the mildew. One winter wash costs the grower 10s. 6d. per 100 gallons, and there is no scientific evidence that it is of the slightest use against the winter-stage of the mildew ; one of the summer washes costs the grower 8s. 6d. per 100 gallons, and if this contains the right amount of potassium sulphide in the right chemical condition it will be as effective against the mildew as the well-known spray of potassium sulphide and water, which the grower can easily make for himself at a cost of about 1s. 6d. per 100 gallons.

Amongst the most important educational work of the Board of Agriculture should be that of preventing fruit-growers from being exploited by the sellers of useless, proprietary spray-fluids. Now that legislation is in force compelling spraying in certain cases, this work becomes a matter of real importance. Although no grower can be protected from himself if he makes up his mind to expend his money on some useless proprietary wash, yet a very large part of the losses incurred in this country by the use of such washes could be prevented if the Board of Agriculture were capable of giving authoritative advice and information on the subject. In the present case prompt action, and insistance from the first on the fact that no winter-spray is of any use, and that the most efficacious summer-spray has been proved to be a solution of "liver of sulphur," and that this is very cheap and no trouble to make, would have saved growers, to a large extent, from wasting their money. No other spray but freshly mixed home-made "liver of sulphur" wash should have been officially approved for compulsory use under the Board's Order ; the grower being left free, of course, to carry out any additional experimental spraying with what proprietary sprays he chooses to use.

Not only has this opportunity of making a start in valuable educational work been neglected by the Board, but a grave case of official negligence or want of judgment has occurred. In December last a proprietary wash, made by a private individual at Wisbech, was advertised as "the first wash in England to be approved of by the Board of Agriculture as a remedy for American Gooseberry Mildew." This wash is sold at 7s. 6d. per 100 gallons, and as it was thus advertised, until last May, as having the special approval of the Board, it is very probable that the maker's statement that 7,000 gallons had been sold in the Wisbech district alone, is correct. The point to be considered here is not whether the right amount of "liver of sulphur," in the right chemical state, is present (when, as a wash for the mildew, it would be of the value of 1s. 6d. per 100 gallons), but that the Board took no steps whatever to prevent this incorrect use of their name, for six months, as advertising a proprietary wash, although they must have known of the matter through their Inspector at Wisbech. As a matter of fact, the approval of the fungicide to be used under the Board's Order, rests, at present, not with the Board, but with the Local Authority, and in the Board's "Third Memorandum on American Gooseberry Mildew," issued on May 23rd, 1908, it is stated that "the Board have not formally approved spraying materials prepared by private firms." Yet, for the previous six months, the Board allowed the above statement to go uncorrected. The whole matter is one of immediate practical importance, since it will be necessary if spraying is to be of any use at all, that applications of the spray be made at intervals of not less than ten days throughout the summer months, and oftener if rain falls. As many as fifteen sprayings may be necessary, and if the Board really have the intention of seeing that these are carried out, they should take the greatest care that the proper spray to use costs the grower as little as possible.

Further evils will undoubtedly result if, as at present, the choice of the compulsory fungicide to be used is left to the Local Authority. It is necessary, in the interests of fruit-growers, that the approval of all fungicides should rest with the Board, and that the Board should publish a list of the approved fungicides. Both these points have been obtained by the farmer in the matter of sheep dips, and compulsory dipping. At the present time, it is practically impossible to obtain information as to what proprietary sprays are permitted to be used under the Board's Order. On writing for this information, the Board gives the answer that, as the approval rests with the various Local Authorities in the affected districts, information can only be obtained from them. This method of obtaining the facts would, of course, be a most laborious task, and if the Board had a right conception of their scientific duties, would not be left to private individuals.

Through the inefficiency of the present organisation at the Board of Agriculture the interests of fruit-growers are being seriously neglected, with the result that—among other things—this lately introduced mildew is on the point of being allowed to establish itself firmly in the counties to which it has been introduced, and to spread sooner or later through the whole of England.

I shall be glad to hear from all those who are willing to join together to make a combined and final effort to save the gooseberry plantations of this country from becoming permanently affected with this most destructive pest.

July 13*th*, 1908.

The "Warty Disease" or "Black Scab" of Potatoes.

(*Chrysophlyctis endobiotica* Schilb.)

In 1906, in an article on "Fungus Diseases and the Need for Legislation"[*] I called attention to the introduction into England of a new and destructive potato disease, and emphasised the necessity of the Board of Agriculture taking steps at once to prevent the disease spreading through the country.

For the last two years I have taken every opportunity of pointing out, over and over again,—by means of lectures, and by letters to the press, as well as by correspondence with and by deputations to the Board of Agriculture, and by getting Questions asked in the House of Lords and in the House of Commons,—the economic importance of the matter, and the foolishness of allowing year after year to drift by before starting to stamp out the disease while it is confined to a few localities.

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[*] *Journal of the South-Eastern Agricultural College*, No. 15, July, 1906.

With full evidence before them as to the dangerous nature of the disease, the Board have allowed year after year to pass without taking action. As long ago as 1901 the Board were aware of this new disease invading the potato crop; for seven years they have remained inert. Until 1907 no steps were taken to obtain the necessary legislative powers for dealing with such pests, and when in July, 1907, the necessary powers were given to them in order to deal with the American Gooseberry Mildew (see p. 260), they showed no initiative or inclination to take steps to stamp out this potato disease. They have said that they "recognise the dangerous nature of the disease"; they have expressed "sympathy"; and they have at last promised to deal with the disease under the new "Destructive Insects and Pests Act"; but so far their only action has been to publish an official leaflet, badly illustrated and containing unscientific statements which, after strong representations, are now to be withdrawn. In their treatment of the present disease we have a typical instance of the methods of procrastination, lack of organisation, and absence of scientific knowledge, which, at present, characterise the English Board of Agriculture.

Before proceeding to discuss what are the steps that require to be taken, I will describe the appearance and nature of this new potato disease, and its present distribution.* We shall see that in the absence of any preventive steps being taken by the agricultural authorities the disease has already spread to several counties in England and Scotland. I will mention then the more important events which have led up to the Board's promise to take legislative steps against the disease. The present case shows very plainly that a considerable expenditure of time and energy is at present required before any headway at all is made against the apathy and lack of scientific knowledge exhibited by the Board of Agriculture.

In 1902, this new fungus disease of Potatoes was first recorded for England. Prof. M. C. Potter, of Armstrong College, Newcastle, gave an excellent and well-illustrated account of the fungus causing the disease, in the December number, 1902, of the *Journal of the Board of Agriculture.* In this article the fungus was correctly determined as *Chrysophlyctis endobiotica* Schilbersky, which had hitherto been known only from Upper Hungary, where it was originally discovered in 1896. In the same number of this *Journal*, the same disease was dealt with by Mr. Massee, (of Kew), who determined the fungus as *Œdomyces leproides* Trabut, a disease which had been recorded as attacking Beetroot in the grounds of the School of Agriculture at Rouiba, near Algiers. It at once became evident that an error had been made in this identification, but the leaflet on "Black Scab" which is still being distributed by the Board of Agriculture continues to perpetuate the mistake of identifying this new Potato disease with that of the Beetroot gall-fungus, *Œdomyces leproides*. The matter is of some economic importance, and I shall refer to it again later.

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* This account is taken partly from an article which I published in the *Gardeners' Chronicle*, 7th December, 1907, and partly from the College Leaflet issued at the same time.

Although this "Black Scab" disease was recognised on its first appearance as being of a dangerous nature, no systematic steps have been taken to eradicate it, or to prevent it spreading through this country. I have collected information from reliable sources, and received a large number of specimens from various districts, which show clearly the dangerous nature of the disease. It is evident, too, that the disease is slowly and surely spreading from county to county. It will be best to give the facts bearing on these points under the various counties from which the disease has been recorded, but before doing so, the disease and the fungus which causes it must first be described.

Description of the Disease.

"Black Scab"* or "Warty Disease" is caused by a fungus known as *Chrysophlyctis endobiotica* Schilb. This fungus attacks the growing potato and causes the formation of wrinkled, warty excrescences. Photographs of potatoes affected with the disease are shown in Plates I-IV., and VII. Sometimes the tuber is attacked at one side or at the end only, when excrescences are formed at the side or end of the potato (Plate III. B.). These excrescences may be larger than the original tuber itself. Frequently the tuber is severely attacked when quite young; when this happens its growth is almost entirely stopped, and the whole potato is turned into a wrinkled, mis-shapen mass, which soon decays or dries up (Plate III. A.). Sometimes lateral shoots of the stem just above ground are attacked, and transformed into a little dense bunch of minute leafy outgrowths (*x* in Plate II.) ; or even the leaves may be attacked, when they develop excrescences. Sometimes, again, the only evidence of the presence of the disease is very minute excrescences round the " eyes," which appear consequently discoloured or blackened (Plate IV.). There is the greatest danger of such diseased tubers being used as " seed," in which case, as the minute excrescences round the " eyes " contain myriads of spores, the disease may be introduced into fresh localities.

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* The name "Warty Disease" is preferable to "Black Scab," as the latter name, apparently, is sometimes used by growers for quite a different disease of the potato, *viz.* the *Rhizoctonia* disease.

Life History of the Fungus.

During the summer months the fungus exists as minute particles of living substance (*protoplasm*) in the cells of the growing potato. This is known as the *plasmodium* stage. In this stage the fungus moves about from cell to cell in the tuber, feeding on their contents, and so irritates and affects the neighbouring cells that they grow out abnormally into the warty excrescences characteristic of the present disease. Wherever excrescences are formed, the fungus produces myriads of spores. At the time potatoes are lifted, each excrescence on being cut across presents, under the microscope, the appearance shown in Plate V. Large numbers of round brown spores (about 60 u. in diameter) can be seen embedded in the flesh of the potato, close to the surface (Plate VI.).* When the diseased potato rots in, or on the surface of, the ground, these spores are set free in the soil, where they remain in a dormant condition during the winter, and then in the following season attack the next crop of potatoes. It has been definitely proved that the spores can remain resting in the soil for two years and then attack the crop in the third year. There is evidence, indeed, which would seem to show that the spores may remain dormant for as long as six years, and then restart the disease when potatoes are planted. The " eye " of the tuber appears to be the part first attacked. The varieties which have been attacked are the following: Up-to-Date, Factor, British Queen, Scottish Triumph, Eldorado, Herd Laddie, and Princess May Kidney. A Nottinghamshire grower reports that the following varieties of "coloured" potatoes—Lord Tennyson, Lillie Langtry, Purple Perfection, Basford Beauty and Clark's Seedling—have remained unaffected when grown amongst diseased crops of white varieties.

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* The germination of these " resting spores " has not yet been observed. It seems probable that they are in reality sporangia, and that on germination they set free " swarm spores " in the soil. They function, however, as " resting spores."

Mr. J. W. Eastham has the following interesting note respecting the prolonged vitality of the spores: "When once established in the land, it is useless to grow potatoes again until the pest has been starved out or otherwise destroyed: but, so far as is known, no other crops are liable to be attacked. Quite the worst case seen in Cheshire occurred on land that had not borne potatoes for six years; 'seed' from the same source as that employed on this land yielded satisfactory results elsewhere, indicating that spores were not introduced by the "seed," whilst the manure employed started no infection elsewhere. This indicates prolonged vitality on the part of the fungus, which would render starving out a very tedious process."

It is quite clear, therefore, that all diseased tubers should be carefully collected *and burnt*. In Mr. Massee's article in the *Journal of the Board of Agriculture* for 1904, p. 307, the advice is given that, as an alternative treatment, diseased tubers should be "*deeply buried*." In my opinion this advice should never have been given. Mr. Massee brings forward no evidence that deep burying would kill the spores, and it is improbable that this is the case; there would be the danger, too, of diseased material or infected soil being brought to the surface by moles or worms.

Diseased tubers should on no account be fed to stock, as the spores would not be injured by passing through the intestinal canal of the animal, and would eventually be returned to the land with the manure.

Present Distribution of the Disease and its Dangerous Nature.

1. Cheshire.—Mr. J. W. Eastham has written (in the Year-Book of the College of Agriculture, Holmes Chapel, for 1904) of the serious nature of the present disease, which appears to be not only very well established but spreading in Cheshire. "The first re-

corded case of attack in this county was in 1900, when a field of potatoes was destroyed near Birkenhead. I am informed, however, that so long ago as 1896, specimens of tubers affected were sent to the College from Cheshire, but nothing was then known concerning it. In a mild attack the tubers are disfigured, but not seriously damaged, and their keeping powers are not injured. In a severe attack, however, the tubers are practically worthless, while if the young sprouts of the seed should be affected, the growth of that plant may be entirely stopped, and no tubers at all produced." Mr. W. Neild, lecturer in horticulture at the Holmes Chapel Agricultural College, has very kindly supplied me with the following notes: "I have to report that the disease is spreading and the damage done is very considerable. The fungus is spreading through the distribution of affected seed, and growers whose crops have suffered from it either don't or won't admit its presence on their holding as it would militate against the sale of 'seed.' I first heard of it in 1895, and the following year specimens were sent to me; these I forwarded to London, but nothing appeared to be known there about it. It is generally believed in Cheshire that it was introduced to this county by the cattle-boats from the Continent arriving at Birkenhead. The worst case I have seen was in a field of about three acres quite near to the College; the variety was Up-to-Date, and nearly every tuber was more or less affected, about one-third of the crop being rendered quite useless. In another instance the Eldorado suffered very extensively." Writing later, Mr. Neild reported: "I have just met with a very bad case. The field in which the disease occurred had been pasture, which was broken up last year; area, six acres; variety, Up-to-Date. The haulm was strong, but the crop was not worth harvesting, as every tuber was affected with disease. I may add that cottagers and others who have known the disease long before it was designated 'Black Scab' know it by the name of 'Cauliflower disease,' doubtless owing to the outgrowths bearing some slight resemblance to a cauliflower" (see Plate VII.).

2. MERIONETHSHIRE.—Prof. C. Bryner Jones, of University College, Aberystwyth, has very kindly supplied me with the following notes on the occurrence of the disease in Merionethshire. It is a highly interesting case, and illustrates how a new pest, when once

introduced, if left to itself, will slowly and surely establish itself in a district. Prof. Bryner Jones writes : " I have personally only come across the disease in one locality in North Wales, *viz.*, Dolgelly, in Merionethshire : I believe I was one of the first to have attention called to it. This was in 1901 and 1902, when I sent specimens to London to Mr. W. Carruthers. These specimens I found in a garden just outside the town of Dolgelly ; this garden was then in the occupation of one of the station-masters, and, so far as I know, was the only place where the disease had then made its appearance. I have made inquiries every year since. The disease is still in this garden. Last year it was also prevalent in another garden about a quarter-mile away from the first one. I was told that the disease had appeared on a farm some distance from the town."

Writing later, Prof. Bryner Jones reported : " Since I received your letter, I have made further inquiries and visited some places in the Dolgelly district, and I am sorry to say that I find the disease is spreading. It is still to be found in the garden (mentioned above) where it first occurred ; for the last two years there has been a good deal of it in another garden (which is let in allotments) about a quarter of a mile from the first garden. This year I have found it in a third garden on the opposite side of the valley, and about a mile from the town. Here, so far as I am aware, it did not appear before this year. There is a little of the disease in a farm also about a quarter of a mile further up, but I could not discover any connection between the two places. In the case of the farm, the " seed ' was their own, grown one year on the farm, and last year there was no disease. In the case of the third garden, above referred to, where the disease is very bad, the ' seed ' was obtained from a provision merchant in the town, whom I have not yet seen to make inquiries of. The owner of the garden tells me that the disease is much worse in the part of the garden planted with this man's seed than it is in another portion of the garden planted with different seed. Its origin seems very mysterious, and it will take a good deal of investigating. I am informed that the disease has also appeared at Festiniog. I am greatly interested in the matter, and somewhat concerned to see the way in which the disease is spreading. I have already acquainted the Board of Agriculture with the fact that it is spreading."

3.—NOTTINGHAMSHIRE. Mr. Geo. Gordon, at a meeting of the Royal Horticultural Society on October 13th, 1903, reported that the present disease "had completely destroyed crops in allotments in Notts." Through Mr. Gordon's help I have been put into correspondence with a grower at Annesley, Notts, who writes as follows: "The disease is spreading each year. It broke out here in a few allotments six or seven years ago, and now scarcely one is free, and there are about 185 of them in our little village. These allotments are from 500 to 1,000 square yards, and some of the occupiers cannot find potatoes in plenty for 'the family' for the winter and spring months, whereas a few years ago the cottager would have abundance. The tubers when dug (freshly) present the appearance of beautiful miniature cauliflowers; tubers only 2 ozs. in weight will produce protuberances twice their size." Writing later, my correspondent adds: "There is no doubt in my mind as to the way the pest found its way here. It would be conveyed from Hungary to Germany, thence to London, then to the provincial towns—Nottingham for one. Then it would be brought round by costers into our village, and the 'seed' would be planted by many. The disease attacks Up-to-Date, Factor, British Queen, Scottish Triumph, and many other varieties."

4.—WESTMORLAND. Prof. M. C. Potter writes to me that he observed the disease at Ambleside last July. (See also below, under Cumberland).

5.—LANCASHIRE. Mr. Carruthers recorded, in 1902, the occurrence of the disease "in Lancashire," with the remark that the tubers were "completely destroyed." During the past season, a number of fresh outbreaks have occurred. Mr. A. Hosking, Horticultural Instructor, has written to me as follows: "We have had several reports of this disease during the past summer. Two from Maghull, near Liverpool, and a very bad case at Fulwood, Preston, where about half-an-acre was so badly attacked that the crop was not worth lifting."

6.—CUMBERLAND.—The disease is recorded from Bootle in the October number of the *Journal of the Board of Agriculture.* In the *Gardeners' Chronicle* for October 26th last, Mr. J. G. Murray reported a very severe outbreak upon about a dozen allotment gardens near Carlisle. In a recent letter, Mr. Murray writes: "I have had reports concerning the disease from four centres in Cumberland and Westmorland."

7.—CLACKMANNAN.—A grower records the following case. "The diseased potatoes were grown in 1906, on a large piece of garden ground at Kennet Village. The varieties grown were British Queen, Up-to-Date, Scottish Triumph, Herd Laddie, and Princess May Kidney. The whole crop was damaged to the extent that they could not be used. They were quite useless, the early varieties being, if anything, worse than the late,—especially the early kidneys. The disease first appeared in the stems as a greenish-looking canker, and attacked the tubers as they grew, and soon made them into a mass of corruption."

8.—PERTHSHIRE.—In the October number of the *Journal of the Board of Agriculture* for 1907 the disease is reported from Crieff. No details of the outbreak are given, and so far as I can ascertain it has not been officially investigated at all.

9.—STIRLINGSHIRE.—Outbreaks have occurred in this county.

With regard to the Scotch outbreaks Dr. Borthwick (of the Edinburgh Botanic Gardens), who has studied the disease closely, has written : "No doubt new centres of infection will be reported from time to time as the disease spreads and becomes better known. Preventive measures to be effective must be adopted by all growers of potatoes ; individual or isolated action, although productive of some good, may be of no avail in a case of this kind, nor in the case of any other threatened epidemic. The health of the potato crop in Scotland is of extreme importance, not only to the country itself, but to other countries to which 'seed' potatoes are sent ; hence no effort should be spared in order to stamp out this new and recently introduced enemy to such an important food crop."

Soon after the determination of this Potato disease, by Mr. Massee, as being identical with the Beetroot fungus, *Œdomyces leproides* Trabut, a statement was made by Dr. M. C. Cooke in the *Gardeners' Chronicle* to the effect that he had been assured by some-one that Dr. P. Magnus, of Berlin—an authority on this group of fungi—had acquiesced in the determination. Immediately on this statement being published, Prof. Magnus wrote to the papers contradicting it, and pointing out that, from the published description given, *Chrysophlyctis* was evidently distinct from the Beetroot fungus, *Œdomyces.* Later, Prof. Magnus, having seen specimens of the present disease, has pointed out that the fungi causing the two diseases are perfectly distinct, and belong to two different genera. Unfortunately the confusion has been made more serious by the erroneous statement which appears in the Board of Agriculture's leaflet (No. 105) on "Black Scab," that "*Œdomyces leproides* Trabut=*Chrysophlyctis endobiotica* Schilb." The Board of Agriculture should in the next issue of their leaflet delete the name of *Œdomyces leproides.*

A most important question from the economic point of view is whether this new disease of potatoes can attack other plants. Mr. Massee, in the Board's leaflet, where, as mentioned above, the fungus is determined as the same as the beetroot disease, states that "both beet and mangold are liable to be attacked." As no detailed account of the innoculation experiments on beet and mangold have been published, I wrote to Kew for information on the point, and received the following reply: "Seedlings of beet and mangold in soil infected with material obtained from potatoes were attacked and destroyed. Resting spores were found in the tissues of both beet and mangold. No independent announcement of the above observation has or will be made."

If we turn to Mr. Massee's account of the present disease,* we find that it is stated that the present potato disease "proved on microscopical examination to be identical with the one attacking beetroot as described above." Now Mr. Massee describes the outgrowths produced on beet as "containing numerous irregularly-shaped cavities filled with the dark-coloured resting spores of the fungus." But in the potato disease we do not find "irregularly-shaped cavities filled with spores," but, as Prof. Potter has pointed out, the spores are scattered in the cells of the tuber near the periphery. How, then, is it possible to maintain that the two diseases are microscopically identical? When we come to consider the spores, a graver discrepancy occurs. Mr. Massee figures, as coming from a diseased potato, spores which show a lateral depression; but, as Prof. Potter and Prof. Magnus point out, the spores do not show this character, while it is found in the quite distinct disease of the beetroot. It is the very reverse of scientific treatment to attempt to remedy these discrepancies by stating, as is done in the Board's leaflet, that the potato disease, *Chrysophlyctis endobiotica*, is to be considered as a synonym of the beetroot disease, *Œdomyces leproides.*

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* *Journal of the Board of Agriculture.* December, 1902.

The time is now at hand when potato growers with land infested with spores of the "Black Scab" will be forced to grow other crops for a number of years, and it is of public importance either that the scientific details of the inoculation experiments, on which the Board of Agriculture rely for the statement (published in their leaflet) that beet and mangold are liable to be attacked, should be published, or that this leaflet should be withdrawn.

We now come to the consideration of the point; what steps ought to be taken to prevent this new potato disease spreading through the country?

There is a consensus of scientific opinion as to the dangerous nature of the disease. Prof. M. C. Potter has written: "From my observations it is evidently a very destructive parasite, which possesses most effective means of spreading itself if only opportunity offers. As, so far, it appears to be of local occurrence, it is of the highest importance to stamp it out before it obtains a firm foothold in this country. The attacked potatoes should in no case be allowed to pass out of an infected district or be used for 'seed.' It is worth while taking every possible precaution to check this parasite, which otherwise might ensure for itself a wide distribution and cause very considerable damage."

The opinions of Mr. J. W. Eastham, Mr. W. Neild, and Prof. C. Bryner Jones, who have all had practical experience of the disease, are given above. Mr. Massee has even written: "This disease although only quite recently imported from the Continent, threatens to be quite as destructive to potatoes as the old-established disease." If we consider what these words really mean, and the devastation and famine that would result—supposing this estimate of the dangerous nature of the disease to be correct—if this new pest should gain admission into Ireland, it seems almost incredible that the Board of Agriculture should have taken no steps, beyond the issue of a leaflet, to deal with the disease. But, considering that the present "Black Scab" disease has no aerial form of fructification and so cannot spread above ground like the potato " blight " (*Phytophthora infestans*), which may extend in a few days through a whole field by means of its wind-borne spores, the two diseases cannot, in my opinion, be thus compared, and we must hope that for once Mr. Massee may be regarded as somewhat of an alarmist and as exaggerating the spreadin pogwers of the disease.

It is quite clear, however, that the " Black Scab " disease threatens to inflict such serious injury on the potato crop as to warrant the Board of Agriculture taking official action. The Board now possess the necessary legislative powers under the " Destructive Insects and Pests Act," which become law last July. The disease is viewed with alarm by both the scientific and the practical man, and if allowed to spread through the country and to reach Ireland will cause losses of hundreds of thousands of pounds. Now that the disease is reported from three Scotch counties it can only be a matter of time, if the agricultural authorities continue to remain inactive, before the disease is distributed by Scotch " seed " over the whole country.

Since this disease has only recently been imported into this country from the Continent, and is at present confined to a comparatively small area, it is eminently a disease to be dealt with by legislative measures. It is perfectly clear that growers will continue to send the disease about the country by means of diseased " seed," unless it is made a punishable offence to do so. The spread of this new disease can only be prevented by the affected areas being kept under the supervision of a competent inspector. The disease should be dealt with as the Colorado Beetle was dealt with, and potato growers should unite in demanding from the first that some compensation from Treasury funds is paid for partly-diseased crops which are destroyed for the public good. Such compensation was given when the Colorado Beetle Act of 1877 was put into force.

From past experience, it seems hopeless to expect the Board of Agriculture to act on their own initiative in dealing with any newly-introduced plant disease, and I would therefore strongly recommend all potato growers and merchants, farmers, market gardeners, and allotment holders to unite in sending resolutions to the Board, urging them to take immediate steps to eradicate this new pest, or at least prevent it from spreading all over the country.

The essence of the scientific treatment of epidemic plant diseases is to apply the remedy at the start. A conspicuous instance of the danger of neglecting this principle can be seen in the present situation with regard to the American Gooseberry-mildew. The Board knew of outbreaks of this disease in 1900, yet took no steps to deal with this pest until seven years afterwards, with the result that they have now to deal with some hundreds of acres of Gooseberry plantations infested with this most infectious mildew. The Board knew in 1901 of the introduction into this country of the " Black Scab " of potatoes. Since 1901 the disease, as the above evidence from the various counties shows, has been slowly and surely extending its area.

A Leaflet* on the subject was issued from the College on December 23rd last, in which the following suggestions and observations were made as regards " Remedies." " The first step is to awaken the Board of Agriculture to the necessity of dealing with this disease under the 'Destructive Insects and Pests Act.' *It is most important that any measures contemplated by the Board against the disease are both scientific and framed on an equitable basis so as to secure the co-operation of the grower.* Through neglecting this point, the attempts of the Board to stamp out another recently-introduced pest, *viz.*, the American Gooseberry-mildew, are likely to prove futile, in which case gooseberry growers are in all probability about to suffer very severe losses. The present leaflet is issued in the hope that all potato growers and merchants, farmers, market and private gardeners and allotment holders will take immediate steps, by means of resolutions or deputations from farmers' clubs, or kindred societies, to awaken the Board to the necessity for suppressing this new potato disease before it is too late.

" It cannot be too emphatically pointed out that if this new disease is allowed to become widespread, it will in all probability cause in future years, the same trouble and loss to the farmer in his potato fields as the closely allied 'Finger-and-Toe,' 'Anbury,' or 'Club-root' disease now causes to his turnips."

Copies of the College Leaflet were widely circulated through the counties of Kent and Surrey, and were also sent to the agricultural press, and to a large number of representative growers in those counties in England and Scotland where potatoes are grown extensively.

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* This Leaflet, in which the disease is fully described and illustrated, can be obtained on application to the Secretary.

Lectures were given at farmer's clubs, and to various horticultural associations, and, as a result, resolutions have been sent to the Board of Agriculture, urging them to take legislative steps against the disease.

In a letter to the press* I pointed out the following facts: "In 1877, when faced with the possibility of the spread in this country of a dangerous pest of potatoes, known as the 'Colorado Beetle,' the Government lost no time in passing 'The Destructive Insects Act, 1877.' By an order under this Act the local authority was authorised to destroy the affected crop, and as private property was destroyed for the public good, a sense of justice led the Government to pay compensation from Treasury funds.

"Since 1902, the Government have been confronted with the gradual spread of a dangerous disease of potatoes known as 'Black Scab,' and have taken no legislative action against the disease. I have recorded in the *Gardener's Chronicle*, of December 7th last, the losses already experienced, and shown that not only has the large grower suffered, but that, in some cases, the allotment holder has not been able to harvest sufficient sound potatoes for the needs of his own family. The dangerous nature of this new disease is admitted on all sides; the Board's official expert even goes so far as to write:—'This disease, although only quite recently imported from the Continent, threatens to be quite as destructive to potatoes as the old-established disease.' There is the certainty, under present conditions, of this 'Black Scab' being distributed through the country by diseased seed from the nine counties (three of them Scotch) where outbreaks are at present known. To deal with this disease drastic and compulsory measures are necessary, as in the case of the Colorado Beetle. Such measures should be demanded at once by all potato growers, with the payment of compensation in cases where it is necessary to destroy a partly diseased crop.

"The drastic measures necessary to stamp out the American Gooseberry-mildew have failed to be carried out without the payment of compensation. Compensation having been refused, half-measures are now being contemplated which are certain to prove uneconomical in the end.

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* See *e.g. The Standard*, December, 1907.

"The potato is of far greater importance than the gooseberry, and the Board should hesitate no longer to proceed against this new disease by scientific measures framed on an equitable basis so as to secure the co-operation of every grower."

At the instigation of Wye College, Questions were asked both in the House of Lords and in the House of Commons as to the intention of the Government to take steps against the disease. At length, early in 1908, a definite promise was given, in the House of Lords, by Lord Carrington, the President of the Board of Agriculture, that the disease should be dealt with under the "Destructive Insects and Pests Act."

As, however, the months passed by without any sign of action on the part of the Board, I brought the matter before the National Fruit-growers' Federation, who, on April 3rd, sent a deputation to the Board on the matter. This deputation put forward the following suggestions for the extermination of the disease.

1. That the "Black Scab" of Potatoes be made a notifiable disease under the "Destructive Insects and Pests Act, 1907," with the object of enabling the Board of Agriculture to ascertain at once the exact areas at present affected.

2. That where the disease is known to exist on any farm or holding it shall be illegal for the grower to sell any potatoes until the same shall have been examined by an inspector from the Board of Agriculture or duly qualified person; and that all potatoes found to be diseased shall be destroyed, the grower to be compensated for the same up to half their value,—such compensation to be paid from the Treasury Funds.

Further, that every grower who, within a determined period of years, plants potatoes in ground where the disease has previously existed shall be required, before offering the crop for sale, or allowing it to be removed, to possess a certificate from the Board of Agriculture certifying that the same is free from the disease.

3. That the Board of Agriculture be requested either to publish the scientific details of the investigations on which the following statement (published in the Board's Leaflet) is based, *viz.*: That the Black Scab of Potatoes is able to attack mangold and beet;

or to withdraw this statement, and to substitute the scientific name *Chrysophlyctis endobiotica* for that of *Œdomyces leproides* (the beetroot disease) at present used by the Board, and in the latter case to place no restrictions upon the growing of mangel or beet on land contaminated with the Black Scab disease of Potatoes.

4. That, in view of certain statements that have been made, the Board of Agriculture be requested to investigate as to whether the disease is being introduced into this country by means of imported "seed."

5. That in view of the enormous importance of the health of the potato crop to the public generally, the Board of Agriculture should convene a gathering of representative Potato-growers, and others interested scientifically or commercially in the matter, to consider the whole question of the best means of carrying out the necessary preventive measures.

After a long discussion, the Secretary to the Board (Sir Thomas Elliott) proposed that the Federation should bring to the Board a number of representative potato growers to discuss the whole subject. At very considerable trouble the Federation gathered together on May 7th, not only practical growers from England and Scotland, but also those agriculturists, horticulturists, and scientists who had specially studied the disease. The Deputation was composed of the following: Col. C. W. Long, M.P. (who introduced the members of the deputation); Prof. M. C. Potter, of Armstrong College, Newcastle; Prof. T. J. Young, Principal of Holmes Chapel Agricultural College; Prof. C. Bryner Jones, of University College, Aberystwyth; Mr. J. G. Murray, Horticultural Inspector, Carlisle; Mr. T. A. Scarlett, of Edinburgh; Mr. A. J. Brown, of Sutton, Surrey; Mr. J. Stephenson, of Althorpe, Doncaster; Mr. A. M. Gordon (representing the Highland and Agricultural Society of Scotland); Mr. A. H. H. Matthews, representing the Central Chamber of Agriculture; Mr. W. Miskin, Secretary of the National Fruit-growers' Federation; and myself.

The first four suggestions mentioned above (which had previously been approved by all the members of this deputation) were again put forward and the importance of the matter was pressed home on the Board by many of the delegates. In the full discussion which took place, cases were cited where holders of certain allotments had been compelled to give up growing potatoes in consequence of the disease completely destroying the crop season after season, as a result of the soil having become thoroughly infected, within three years from the first outbreak. The Deputation was informed by Prof. T. H. Middleton, on behalf of the Board, that " they recognised the serious nature of the disease," and that they would give a promise that " the disease should be made a notifiable one,"* but that (beyond agreeing to withdraw or modify the Board's Leaflet as suggested in No. 3) they " could not entertain the idea of doing more at present."

Now if this new potato disease is to be stamped out, it is perfectly certain that more vigorous action must be taken. Drastic measures are required, such as those proposed above (No. 2) to the Board.

I would call the earnest attention of all agriculturists to the following facts. In the forties a fungus pest of potatoes, till then unknown in this country, began to attack the crop. This was the now well-known potato " blight " (*Phytophthora infestans*), which was introduced into Europe from America. The disease now occasions annually enormous losses to growers, and, it will be remembered, has been the cause of famines in Ireland. According to the published statement of the Board's own expert—Mr. Massee, of Kew—the new " warty disease " of potatoes " threatens to be quite as destructive to potatoes as the ' blight.' "

At present the new disease is strictly localised in some nine counties in England and Scotland. From the infected areas in these it is, in the continued absence of any action on the part of the Board, slowly and surely spreading year by year. At present it is unknown in Ireland.

After the " blight " had spread beyond control through this country, it began to be investigated by the agricultural authorities. Will not the Board of Agriculture learn by past experience? Growers will willingly submit to the necessary restrictions (if these are framed on an equitable basis), in order to prevent a new disease destroying their crop, if they are convinced that the Board are determined to stamp out the pest.

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* An Order making the present disease a notifiable one was issued on June 18th, 1908.

If the work is started at once, with energy, and proper organisation, and scientific guidance, it would not even now be a superlatively difficult task for the Board to stamp out this new potato disease within the next ten years—or even sooner. But each year of inaction makes the work more and more difficult, and more and more expensive to the nation.

It is clear, however, that fresh legislation empowering the Board to give some measure of compensation is urgently required. It must be remembered that, owing to their inability to give compensation, the Board have failed to carry out their first Order against the American Gooseberry Mildew,—the first disease they proceeded against under the new Act, and have been obliged to substitute a second, milder Order, in the efficacy of which they themselves can have but little faith.

In the past the Board have shown more energy and determination in carrying out scientific measures against diseases than they show at present, as witness the stamping out of rabies and the Colorado Potato Beetle. In the latter case the Board paid compensation from Treasury funds for the potatoes compulsorily destroyed. But judging from the methods of procrastination which have, of late, characterised the Board, it appears that they are, at present, too ill-organised to carry out the work of fighting plant pests, for which the " Destructive Insects and Pests Act " of July, 1907, gave them powers.

At present the Board are doing absolutely nothing to protect the farmer from the danger of this new disease reaching his farm. As an instance of the futility of the Board's methods it may be mentioned that last autumn several potato growers from Kent and other counties wrote to Wye College for information as to what districts in Scotland were known to be affected with this disease, as they wished to guard against the danger of introducing the disease into their district by the purchase of affected " seed." On applying for detailed information as to the affected districts in Scotland, the Board replied (although the disease had, at that time, just been recorded for Perthshire in their *Journal*), that " they were unable to give this information."

No work is more urgently required than that of the official investigation and mapping out of the areas in England and Scotland at present affected with this disease. The speedy publication of this information would enable farmers either to avoid these districts when purchasing "seed," or to scrutinise carefully any "seed" obtained from such districts; it would also help to make the growers in the affected areas do all they could to stamp out the disease, so that their district could be declared free.

It is clear that the health of the potato crop in Britain is seriously threatened. In the absence of an Independent Agricultural Party in the House of Commons, agricultural matters of the greatest economic importance receive little or no attention. I trust, however, that searching questions on the present subject will be asked in the House by Members representing agricultural constituencies, so that the work of stamping out this new disease—which should have been commenced seven years ago—is now taken up at once in an earnest and scientific manner. Unless public attention is called to the danger by Questions in the House, there is but little hope of the matter receiving proper attention from the Board.

For the benefit of those who wish to consult the various articles which have been written on the present disease, the following list is given:—

Schilberszky; Ein neuer Schorfparasit der Kartoffel-knollen (Berichte d. Deutsch. Bot. Gesell. Bd. XIV. (1896).

M. C. Potter; A new potato disease (Journ. Board of Agriculture, ix. p. 320 (1902); Note on the "Warty Disease" and "Corky Scab" of the Potato (Journ. of the Newcastle Farmers' Club, July, 1908).

G. Massee; (Journ. Board of Agriculture, ix. p. 307, 1902); Journ. R. Hort. Soc., xxix. p. 143 (1904).

R. S. Macdougall; New fungus disease of potatoes (*Chrysophlyctis endobiotica*) (Trans. Highland and Agric. Soc. Scotland, p. 312 (1903).

W. Carruthers; in Journ. R. Agric. Soc. England, lxiii. p. 292 (1902); *l.c.*, lxiv., p. 305 (1903).

P. Magnus; in Gardeners' Chron., xxxiii., p. 329 (1903); Journ. R. Hort. Soc., xxviii., p. clxxix (1904).

M. C. Cooke; in Gard. Chron., p. 187, September 19th (1903).

Journ. R. Hort. Soc., xxvii., p. 1180 (1903); *l.c*, xxviii., p. clxxviii. (1904).

W. G. Smith ; in Gard. Chron., October 29th (1904).
R. N. ; l.c., September 19th, 1903 ; *l.c.*, p. 372 (1904).
J. W. Eastham ; " Black Scab " of Potatoes (Yearbook of the College of Agric. and Hort., Holmes Chapel, 1904, p. 11).
A. W. Borthwick ; " Warty Disease " of Potato (Notes, R. Bot. Garden, Edinburgh, xviii., August, 1907).
J. G. Murray ; in Gard. Chron., October 26th, 1907.
E. S. Salmon, ; " Black Scab " or " Warty Disease " of Potatoes (Gard. Chron., December 7th, 1907) and Leaflet, S.E.A. College, January, 1908.
Board of Agriculture and Fisheries (England), Leaflet No. 105.
Department of Agriculture and Technical Instruction (Ireland), Leaflet No. 91, February, 1908.

Apple "Scab" or "Black Spot," and its Treatment.

CONIDIAL STAGE, *Fusicladium dendriticum* Fckl. ASCIGEROUS STAGE, *Venturia Pomi* (Fr.) Wint.

There is no single fungus disease—with the possible exception of " canker "—which at the present time is doing so much damage in apple plantations and orchards in England as the " Scab " or " Black Spot." Losses of many thousands of pounds are being occasioned annually by this disease. In severe attacks it may injure the crop to such an extent that it is not worth gathering, and wherever it is present to even only a slight degree it depreciates the market value of the crop to a marked extent. The thoroughly inferior quality of the English apples which are so often exposed for sale in provincial towns is due almost entirely to the prevalence of " scab." The value of the improved scientific methods adopted by growers in foreign countries and in our Colonies is nowhere seen more clearly evident than in the clean apples,—kept entirely free from " scab " by spraying,—which are exported to us.

It is, therefore, impossible to over-emphasise the importance of the following facts, first, that this disease occurs on the leaves and also, frequently, on the young wood, that is, *it is not confined to the fruit alone,* as the grower almost invariably thinks; secondly, that by spraying systematically, at the right time and with the right fungicide, the young wood (when affected), the leaves and the young fruit, a perfectly clean crop of well grown out apples can be obtained from trees which have previously been producing a " scabby " crop season after season.

The important facts relating to the life-history of this fungus pest are as follows.

The disease usually first attracts the attention of the grower by its injury to the young fruit. In the case of orchards where " scab " has been prevalent for a number of seasons, and so has become firmly established, it is not uncommon to find the young apples on certain varieties of trees becoming so severely attacked that they present the appearance reproduced in the photograph in Plate IX. The further growth of apples which are attacked as severely as this is almost entirely stopped, and the crop is, at any rate, practically worthless. If, as in the case of other less susceptible varieties of apples, the disease does not altogether prevent further growth, the apple by the time it has attained full size is either misshapen, owing to the diseased parts having been prevented from developing, or (if the apple attains a fairly good shape and size) its appearance is disfigured by the presence on the skin of a number of " black spots " or " scabs," which depreciate its market value very considerably.

Now, the presence of " scabby " fruit on a tree is almost certain indication that the disease is existing on the leaves or young wood of the same tree, or of neighbouring trees. And it is to the prevention of the growth of the fungus on the leaves that the grower should pay special attention, since if the leaves are sprayed and kept clean the disease can be easily suppressed.

If the leaves are examined closely, they will be found to bear the fungus, usually on the upper surface of the leaf, but often on the lower surface as well. The exact appearance of the disease on the leaf of the apple varies considerably according to the variety of apple, but in every case the part actually infested is covered with dark brown or olive-green " sooty " patches. Sometimes these patches are separate from one another and very distinct,—as in Plate VIII., A. ; at other times the fungus follows more or less closely the " veins " or " nerves " of the leaf on its upper surface (Plate VIII., B.) ; in the case of other varieties, again, the leaf, where it is attacked, forms on the upper surface little swellings or eruptions, over which the fungus spreads its dark brown spores ; or, finally, the whole of the upper surface of the leaf may be coated almost continuously with a very thin dark brown " sooty " covering.*

If a section of an apple leaf is cut across one of the " sooty " patches on the leaf, such as is shown in (Plate VIII., A.), and placed under the microscope, it presents the appearance shown in Fig. 1 (see p. 315). The spawn (*mycelium*) of the fungus can be seen running between the cells in the interior of the leaf, (Fig. 1, *b*) where it feeds on the cell-sap ; at the surface of the leaf it sends out into the air short branches, at the ends of which the minute dark brown spores, or *conidia*, are produced (Fig. 1, *c*). Some millions of these minute spores are produced at each " sooty " place on an apple leaf, and each spore on being carried by the wind or rain, or by insects, to the fruit is able to infect it at once, and produce on it the " scab " or " black spot."

It is chiefly in consequence of the grower allowing the fungus to increase on the leaves and to produce there its millions of spores, instead of keeping the leaves healthy by spraying, that his apples become " scabby " each season.

Other injury too,—apart from the infection of the fruit—may result. If the leaves are severely attacked, a premature shedding of the foliage results, with a marked injurious effect on the growth of the tree.

The next important fact in the life-history is that the young wood of certain varieties is liable to be infected, and when this is the case, it may become a regular source of infection to the tree, and surrounding trees, year after year.

In consequence of the increasing extent to which orchards and plantations in Kent were suffering, apple " scab " was one of the first diseases in the county which I investigated. A number of cases were brought to my notice where young trees, often in quite isolated positions, suffered regularly from the disease year after year, suggesting that a continual source of infection was present on the trees. An examination of the trees resulted in the finding of the disease on the young wood. This was the first time the occurence of "scab"-infested wood had been noted in this country, although this stage had been reported from the Continent and the United States.

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* In some parts of Kent the disease on the leaves is known under the name of "soot," or "sooty" fungus, but its connection with the "Black Spot" of the fruit has not been recognised.

The general appearance of young wood attacked by the "Scab" is shown in the photograph in Plate XI. According to the variety of apple attacked, its appearance varies considerably; in some cases, *e.g.* on "Cox's Orange Pippin" the diseased wood becomes somewhat swollen and prominently blistered, as shown in Plate XI., Fig. 1, A.; in other cases, *e.g.*, on "Wellington," the blistered appearance is less prominent, and the shoot is not swollen (Plate XI., Fig. 1, B.). In other cases, as *e.g.* on "Keswick Codling," the "scab" produces isolated characteristic markings, which give a "pocked" appearance to the wood. Severely attacked young shoots may—as in the case of those of "Lord Suffield" shown in Plate XI., Fig. 2—be blistered almost continuously over the surface, and the bark will then subsequently peel off in flakes. I have known such attacks to be mistaken for "canker" by growers. No "rot" or "canker," is caused by the "scab" fungus in the wood*; the growth of the shoot, however, is often much weakened.

If a section of "scab" diseased wood is cut across a "blistered" part, such as is shown at A, *b*, in Plate XI., Fig. 1, it will present the appearance seen in Plate X. At *a* we see some of the cells of the branch; seated on these is the cushion-like mass of fungus spawn (*b*) which forms the "blister," and covering its surface on the outside is a layer of dark brown spores (*c*).

Any of these spores on being blown or carried to the leaves or young fruit in the spring will immediately infect them, and produce the appearance shown in Plate VIII., and in Plate IX.

During the past two seasons I have searched a number of orchards and plantations, with the object of ascertaining what varieties of apples are susceptible as regards the young wood.

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* I have, however, frequently met with cases where the young wood has been attacked by both "canker" and "scab" on one and the same shoot. It is not improbable that the "canker" spores may find an entrance into the wood at places where the bark has been ruptured by the "scab."

I have found "scab" infested wood on the following varieties: Cox's Orange Pippin, Lord Suffield, Ecklinville Seedling, and Yellow Ingestre or Summer Pippin—all severely attacked; Wellington, Cox's Pomona, Warner's King, Gladstone, Councillor, White Transparent and Keswick Codling—less severely.

According to my experience, the young wood of "Cox's Orange Pippin" is almost invariably "scab"-infested if the disease is prevalent in the neighbourhood. In rare cases I have found a few of the weaker shoots actually killed by the disease; consequently it must be reckoned as one of the most susceptible varieties as regards its wood. I have known several instances in which young trees of this variety bearing scab-infested wood have been sent out of nurseries. The wood of "Lord Suffield," too, is very susceptible; I have known cases where it has become so scab-infested,—the bark peeling off in flakes—that the owners have grubbed up the trees, thinking that they were permanently ruined.

As regards its direct effect on the young wood, however, apple scab is not a serious disease, except in the case of very severe attacks on a few specially susceptible varieties. The chief danger arising from the presence of "scab"-infested wood is that the pest thus persists on the trees through the winter months, with the result that apple orchards and plantations which have suffered for several seasons from "scab" are often never wholly free from the disease at any time of the year. In these cases the life-history of the fungus is as follows:—In the spring the *spores* blow from the diseased wood to the young leaves, and the fruit as it is formed, then when the fungus has developed rapidly and profusely (as it does) on the leaves, *spores* are continually blown or carried during the summer months to the riper fruit and also to the young wood; on the latter the fungus persists in a dormant state through the winter months, and in the following spring restarts the disease on the leaves and young fruit.

In mixed orchards and plantations those varieties whose wood is liable to be attacked should be examined in the winter, and *if the disease is present to any serious extent,* the winter wash mentioned below should be applied.

But a word of warning must be given here. It is simply a waste of money (a waste which is at present being much encouraged by agents of firms selling proprietary " spray-fluids " and " winter washes ") to apply indiscriminately a winter wash to a large acreage of trees with the idea of getting rid of apple " scab." *Apple " scab " is not a disease which can be cured by winter washing alone.* Growers should place no faith in the advertisements of proprietary winter washes that claim to cure " scab." I have seen, for example, " scab"-infested wood, which has been well-sprayed with the proprietary fluid known as " V1 " during the winter, producing spores quite unchecked in the spring. The protection of the leaves by the Bordeaux mixture spray described below is always necessary. *It is scientifically and economically sound to wash for apple " scab " in winter only those varieties of trees whose wood has been ascertained to be severely " scab "-infested.*

It is to be noted that apple " scab," when present to even only a moderate degree, not only destroys the appearance of the apple to a marked extent, but also affects most injuriously its keeping qualities. " Scabby " apples, when stored, go rotten more quickly than sound apples. The flesh of the apple at the place where the " black spot " or " scab " exists becomes gradually soft, and lets in the *spores* of the various fungi (" moulds," etc.) which are floating about in the air. The *spores* of these fungi on once gaining an entrance, quickly invade the flesh of the apple, and soon turn it rotten,—forming the so-called " ripe rots " of stored fruit. The photographs in Plate XIII. show apples which are beginning to rot at the " scabby " places on the skin ; in the figure to the left the " rot " is commencing round the uppermost " black spot " or " scab," which is now turned white through the growth of the " mould " which has attacked the apple at this spot ; in the apple to the right the " rot " has proceeded further, as it shown by the sunken area now existing round the place (originally a " black spot " or " scab "), where the " mould " has gained an entrance. In past seasons I have seen, in more than one orchard in Kent, " scabby " apples being attacked even when hanging on the trees.

Remedies.

Apple " scab " can be easily and cheaply controlled by systematic spraying with Bordeaux mixture.

The first application should be made on the young unfolding leaves *just before the blossoms open.* This is a very necessary operation, as I have repeatedly seen, at the time when the apple blossom is out and when consequently no spraying can be done with safety, the " scab " fungus beginning to spread over the surface of the young leaves and forming *spores* ready to infect the young fruit as soon as it is set.

The second spraying should be given *directly the blossom has fallen.* This will protect all the leaves as soon as possible after they have unfolded.

A third spraying should be given two or three weeks later in the case of trees where the disease has been very prevalent.

The Bordeaux mixture should be made according to the following formula and in the following manner.

Copper sulphate (" bluestone ") *	4-lbs.
Quicklime	4-lbs.
Water	50 gallons.

Dissolve the 4-lbs. of copper sulphate in a wooden tub or bucket—*iron or tin vessels must not be used.* The easiest way to do this is to suspend the material, wrapped up in a piece of coarse sacking, in a few gallons of cold water from a stick placed across the top of the tub, or wooden bucket. If this is done overnight, the copper sulphate will be found to be dissolved in the water by the morning. If hot water is used, the copper sulphate, especially if powdered, can be dissolved in a few minutes. Then add water to make twenty-five gallons. Now take the four pounds of quicklime, and put it in a tin pail. Add a few pints of water until all the lime is slaked, taking care to add only a little water at first; in this way a thick creamy paste is obtained. Add water to make twenty-five gallons. We have now twenty-five gallons of copper sulphate solution, and twenty-five gallons of lime milk. When the two substances are thus diluted with water, they can be mixed together by pouring one into the other, or bucketsfull of each can be poured simultaneously or alternately into a third tub,—a wooden bucket being used for the copper sulphate solution. The lime milk

* In purchasing copper sulphate an article of 98 per cent. purity should be demanded; substances described as "agricultural bluestone," usually adulterated with iron sulphate, must be avoided.

must be well strained, and it is advisable to strain again the Bordeaux mixture before spraying. In this way we obtain fifty gallons of Bordeaux mixture of the best quality.

Two points are of primary importance in making Bordeaux mixture. The first is that *quick lime*, in lumps, that is to say, as freshly burnt as possible, is used. Powdered *air-slaked* lime,—such as is often found in builders' yards, will not make Bordeaux mixture. The second point to observe is that the two constituents, *viz.*, copper sulphate and lime, are diluted with water as much as possible (consistent with the formula) *before being mixed.* If concentrated solutions of copper sulphate and lime are mixed together, and water then added to make up the fifty gallons, the resulting Bordeaux mixture will be of a very inferior quality.

Bordeaux mixture is fully efficacious only when freshly made, and will not keep more than a day or two. If more than a day old it requires to be very thoroughly and constantly stirred while being used, and the use of *only freshly-made* Bordeaux mixture is far more economical in the long run, and is here strongly recommended. If a considerable quantity of Bordeaux mixture is intended to be used, the making of *stock solutions* of copper sulphate and lime, which can be kept through the spraying season and used when wanted, saves both time and labour, and is free from all objection. The stock solutions are made as follows:—Take two 50-gallon barrels. In one dissolve 50 lbs. of copper sulphate in exactly 50 gallons of water. In the other slake 50 lbs. of lime by the gradual addition of a little water; to the creamy paste thus obtained add water to make exactly 50 gallons. These stock solutions will keep for months. Before being used, the contents of each tub must be thoroughly stirred, then each gallon of water which is taken out will be equivalent to, respectively, 1 lb. of copper sulphate or 1 lb. of lime. The required amount of stock solution is then diluted with water, according to the formula given above, before being mixed. The "stock" copper sulphate solution must be measured out in a copper or wooden receptacle.

Only freshly-mixed home-made Bordeaux mixture should be used. The various "dry Bordeaux mixtures" put on the market under the name of "Strawsonite," "Vermorite," etc., are not nearly so efficacious.

A simple and reliable test as to whether the Bordeaux mixture, when made, is safe to use as a spray on leaves and fruit is obtained by the immersion in the fluid, for at least one minute, of a bright blade of a penknife. If at the end of that time the surface of the blade is unchanged in appearance, the mixture is perfectly safe to use; if, however, the surface of the blade becomes the colour of copper plate, the mixture is unsafe to use, and more lime milk must be added until it fails to give this reaction.

If an insecticide is required, arsenate of lead* can be added to Bordeaux mixture at the same rate per gallon as when water is used. This addition will keep the leaves safe from the attacks of all caterpillars.

If, as sometimes occurs, an attack of "scab" appears late in the season, affecting the half-grown fruit, it is not advisable to spray then with Bordeaux mixture, as the fruit, when ripe, would be marked with the bluish spots of the mixture. These markings, unless they were washed off, would probably affect the market value, although the slight trace of copper present would be of no danger to the public health. In such cases the fruit may be sprayed with the following fungicide: copper carbonate, 5 oz.; strong ammonia, 2 to 3 pints; water, 50 gallons. Dilute the ammonia with about two gallons of water. Place the copper carbonate in a wooden or earthenware receptacle, and pour on a little of the diluted ammonia; stir vigorously, allow it to settle, and then pour off the solution into another similar receptacle, leaving the undissolved portion behind. Repeat this operation until all the copper carbonate is dissolved, using only as much of the diluted ammonia as is necessary to complete the solution. Then add water to make up to fifty gallons. A clear, light-blue solution will be obtained, which will keep indefinitely. Arsenical washes (arsenate of lead, etc.) cannot be added to this fungicide.

As a rule, however, two or three sprayings with Bordeaux mixture alone will be amply sufficient to keep the fruit clean. The mixture must be thoroughly applied by a spraying machine, provided with a nozzle which gives a fine, misty spray. Enough spray should be given to make the surface of the leaves uniformly wet, *but spraying should cease before the leaves begin to drip.* If Bordeaux mixture (made as described above) is applied in a fine misty spray it will be found to adhere perfectly, and will not be washed off by rain for many weeks. There is no need to add any sticky substance such as treacle, and no advantage is gained by doing so.

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* Arsenate of lead is best obtained in the form of Arsenate of Lead Paste, sold by Strawsons, 71A, Queen Victoria Street, London, E.C.

If the young wood has become severely attacked, as much of it as possible should be cut out in pruning. Then the trees should be sprayed in winter, while the wood is dormant, with the following winter wash: copper sulphate ("bluestone"), 2 lbs.; water, 50 gallons.

This winter wash is fully strong enough to kill the parts of the fungus with which it comes into contact, and there is no advantage gained in using a stronger.

Certain varieties of apples are *specially susceptible* to "Apple Scab," and such varieties should be looked over carefully, and special attention paid to keeping them clean. It is often the case in orchards where this is neglected, that the fungus increases very rapidly on the leaves, fruit or young wood of such varieties, with the result that they form a constant and prolific source of infection to the surrounding trees.

Among the most susceptible varieties are the following:—King of the Pippins, Cox's Pomona, Lord Grosvenor, Lord Suffield, Wellington, Ecklinville Seedling, Northern Greening, Yellow Ingestre or Summer Pippin, and Bismarck.

Among specially *resistant* varieties may be mentioned:—Beauty of Bath, Bramley's Seedling, Newton Wonder, Grenadier, Lord Derby, Queen, The Victorian and Golden Spire.

In view of the great losses resulting to growers from the injury caused by "Apple Scab," I should like to emphasise as strongly as possible, the fact,—now definitely proved,—that this disease can be perfectly controlled by means of Bordeaux mixture. Orchards and plantations which have been producing annually "scabby" crops, can, at a slight cost, be made to yield crops entirely free from the disease.

I would specially caution growers against using the expensive and often useless proprietary washes which—now that spraying is slowly becoming general in this country—are being placed on the market and extensively advertised. In no case are these preparations nearly so efficacious as Bordeaux mixture, or the winter wash of copper sulphate and water, besides costing much more; *in many cases they are quite useless against the disease which they are advertised to cure.*

One class of proprietary washes are composed largely of the chemical substances known as phenols, in which category carbolic acid, creosote, and various waste products obtained in the distillation of tar, are included. Such washes* contain no copper or sulphur, and cannot be recommended for use against fungus diseases such as Apple "Scab."

In Australia the Government have been investigating the claims of a number of proprietary sheep dips, which were said to have a fungicidal value. From the experiments carried out, it is conclusively shown that sheep dips, phenyl, and similar preparations, are not to be compared with Bordeaux mixture as a treatment for "Apple Scab." A warning against a similar class of proprietary washes now being put on the market in this country must be given.

A large number of fruit-growers in Kent, who during 1906 and 1907, have been using Bordeaux mixture, have satisfied themselves as to the economic value of this spray against the "scab." I know of one case where the use, last season, of Bordeaux mixture, in some large orchards near Marden, resulted in a clean crop of apples on trees (of Wellington and Northern Greening) which in previous seasons had always borne very scabby fruit,—in some years the crop being so "scabby" as not to be worth sending to market in baskets. That the "scab" would have been as bad last season—in the absence of spraying—as in previous seasons was shown by the fact that the few trees which were left unsprayed bore a "scabby" crop. In Plate XII. we have photographs of apples (Northern Greening), which are a fair sample of the difference in quality shown by the crop on the sprayed and unsprayed trees. Not only was the owner of the orchard convinced of the efficacy of Bordeaux mixture against the "scab," and also that it paid handsomely to spray, but the foremen and the men under them who did the actual work of spraying, picking and packing the apples, all spoke of the success of the treatment. Several of the men had worked for many years in these orchards, and these all said that they had never before gathered such a crop of Wellingtons so free from "scab."

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* The fluid advertised as V1 belongs to this class, being largely composed of phenols or substances of that nature, dissolved in caustic soda.

The following extract is taken from a letter sent to the College by a Kent fruit-grower, farming near Maidstone, and is typical of a number of reports sent in during the autumn of 1907:—"It may interest you to know that we sprayed our apple trees with Bordeaux mixture this season, and I can truly say that our fruit was never so clean. Several growers who live in this neighbourhood, having seen the beneficial results of its use in our orchards, are going to spray next season." Another grower writes:—"As to 'scab,' I should like you to see my trees as they are vastly improved. You may remember what a dreadful condition my Bismarcks were in. This year they are almost healthy, and have a good crop of apples, mostly free from 'scab.' The trees were sprayed according to your directions, this being the second season of three sprayings. I know you will be pleased to hear of this successful fighting of 'scab.'"

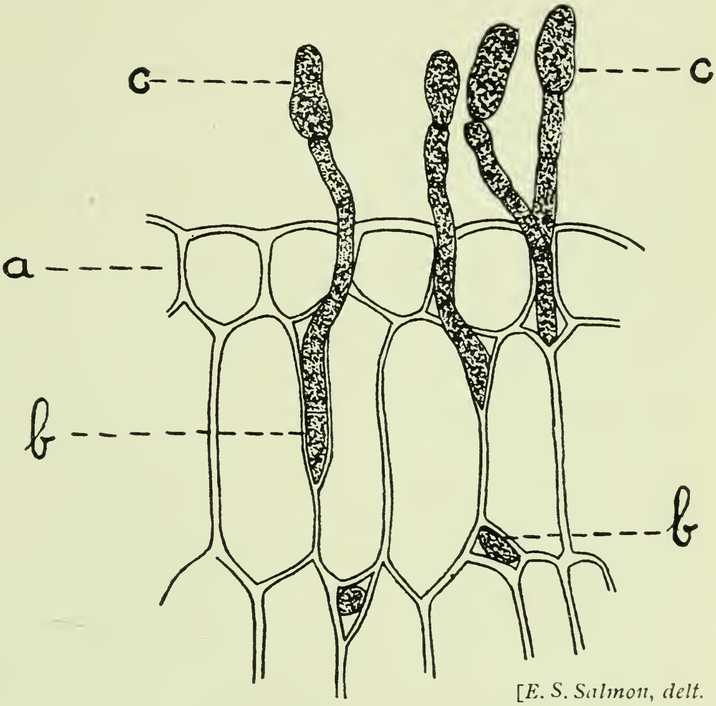


FIG. I.

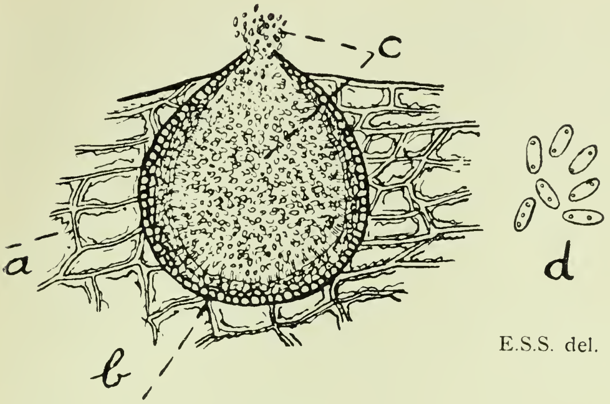
Part of a section through one of the patches of Apple Scab or "Black Spot" on a leaf of "Bismarck" shown in Plate VIII. A.; *a*, epidermal cells of the leaf; *b*, portions of the spawn (*mycelium*) of the fungus feeding on the sap of the leaf; *c*, ripe spores (*conidia*) of the fungus. Highly magnified.

"Leaf-Spot" Diseases of the Apple.

During the season of 1907 fruit-growers in many districts complained that the leaves of a number of varieties of Apples became affected with some disease which turned the leaves brown in places and in some cases caused them to fall. Numerous examples of such leaves were sent to me from a number of counties. After excluding those cases which showed, on microscopic examination, no disease attributable to any organism, and in which the "browning" appeared to be caused by some unfavourable atmospheric conditions, there remained a large number of cases in which it was evident that the damage was caused by certain definite species of parasitic fungi which had attacked the leaves. Some of these are still under investigation. The object of the present note is to draw attention to two definite "leaf-spots," and to the fact that they can be cured by spraying ; also to ask growers who notice any injury appearing on Apple leaves during coming seasons to kindly forward me examples of the same.

One of the commonest "leaf-spots" is that shown in Plate XIV. This is caused by a species of *Phyllosticta*. The disease is characterised by the presence of small, light-brown spots 1 to 3 millimetres across, usually circular, but sometimes oval. These brown spots, which usually occur in numbers on a single leaf, are composed of dead leaf-tissue which has been killed by the fungus, and are so sharply marked off from the surrounding leaf-tissue as to bear the appearance of having been stamped out. Scattered over the brown area can be seen a number of minute black dots. These, which are just visible to the naked eye, are shown enlarged in the photograph in Plate XV. Each black dot is a fruit-conceptacle, or pycnidium, as it is called, of the fungus (see Fig. 1), and contains within it thousands of very minute, oval, colourless spores, each measuring 6 to 8 by 2 to 3 μ.

The second kind of "leaf-spot" is represented in Plate XVI. In this case larger areas of the leaf are killed, and form dark-brown patches of irregular shape, such as is shown in the photograph. When a number of such areas occur on a leaf, or when a single dead patch is of considerable size, the whole leaf may shrivel up and fall prematurely. The fungus causing this "leaf-spot" is a species of *Sphæropsis*. If the dead area of the leaf is examined with a lens, a number of minute black bodies can be seen breaking through the epidermis (see Plate XVII.). These bodies, which are usually arranged in a concentric manner, are the fruit-conceptacles, or pycnidia, of the fungus. Each pycnidium contains many hundreds of comparatively large, oblong, dark olive-brown spores, which measure 25 to 30 by 10 to 15μ. (see Fig 2). The spores are borne, inside the pycnidium, on stalk-like conidiophores, which are often to be found attached to the ripe, or nearly ripe, spore (see Fig. 2, *d*).



E.S.S. del.

Fig. 1.

Fruit-conceptacle and spores of *Phyllosticta*, highly magnified. *a*, cells of the dead tissue of the apple leaf; *b*, a *pycnidium* in section; *c*, spores; *d*, seven spores, more highly magnified.

These two "leaf-spot" diseases, caused by species of the two genera *Phyllosticta* and *Sphœropsis*, have occurred this season on

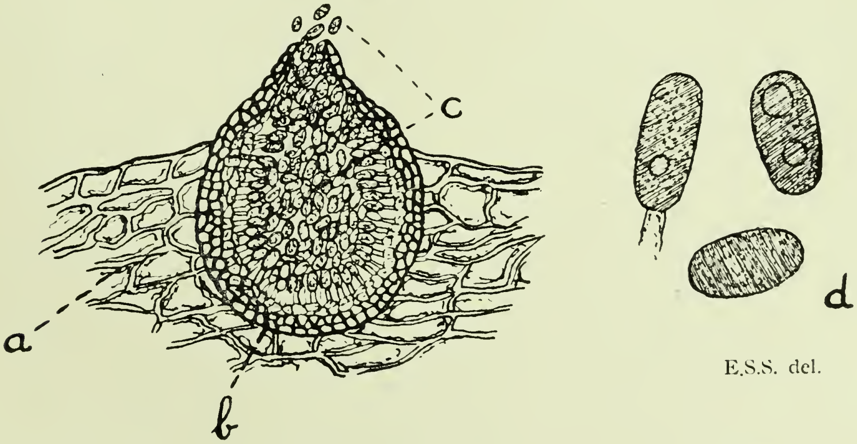


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Fig. 2.

Fruit-conceptacle and spores of *Sphaeropsis*, highly magnified. *a*, cells of the dead tissue of the apple leaf; *b*, a *pycnidium*, in section; *c*, spores; *d*, three spores, more highly magnified.

a number of varieties of Apples, and have been especially prevalent on Peasgood's Nonsuch, Cox's Orange Pippin, Ribston Pippin, and Golden Spire.

In the case of several plantations which I have had under observation during the entire season, it has been very noticeable that these " leaf-spots " have been entirely absent from the trees which have been sprayed with Bordeaux mixture (for apple " scab ") while occurring to an injurious extent on the surrounding trees.

The " leaf-spot " caused by *Sphœropsis* is of special interest, owing to the fact that a species of this genius, *viz.*, *S. malorum* Pk., has been proved in the United States to be the cause of a distinct " canker " of Apple trees, which has been termed the " New York Apple-tree canker." This disease (which until lately had been ascribed to sun-scald) has been very destructive in New York State, as well as in adjacent States, certain varieties of Apples suffering heavily from the injury caused by " cankered " limbs. A full description of this "canker," which differs in several details from that produced by the common " canker " fungus of our orchards, *viz.*, the European canker *Nectria ditissima*, will be found in Bulletins Nos. 163 and 185 of the New York Agricultural Experiment Station. In the latter publication we read: " The leaves of Apple trees are occasionally attacked by a *Sphœropsis*, when injuries appear in the form of round brown dead spots somewhat like those from burning by improper spraying with Paris green. This form of *Sphœropsis* has not been definitely proved to be identical with *S. malorum*, but the indications are that it is the same."

Whether or not the *Sphœropsis* represented in Fig. 2 is the *S. malorum* which causes a special " canker " of Apple trees in the States, it is worthy of notice as being a fungus which is able in this country in certain seasons to cause a definite injury, in the form of " leaf-spots, " to certain varieties of Apples.

It is to be noted, too, that *Sphœropsis malorum* is well-known in the States as the fungus which causes the " black rot " in Apples, not only when the fruit is in storage but also in the ripening stage on the tree (see the Illinois Agricultural Experiment Station, Bull. No. 69).

Whilst I was investigating during the summer of 1907 the " spotting " and " browning " of Apple leaves, and after I had ascertained that the species of *Phyllosticta* and *Sphœropsis* described above are the cause of two definite " leaf-spots," there appeared the Farmer's Bulletin No. 283 of the U.S. Department of Agriculture on " Spraying for Apple Diseases." Here it stated that the fungus diseases which are " quite destructive " in certain Apple orchards are " bitter rot," Apple " blotch," and " leaf-spot." Under " leaf-spot diseases " the following interesting remarks occur : " The disease may begin to appear in the spring, soon after the young leaves unfold, but the spots are usually more prominent between midsummer and the end of the season. This diseased condition causes the leaves to drop prematurely, frequently leaving the trees denuded in early autumn, six weeks or two months before the normal period of leaf-fall. Trees thus deprived of their foliage cease activity, and as a result the fruit is small and not properly matured ; the buds for the crop of the following year are weakened, and in some cases not fully developed, and the life of the tree is materially shortened. These leaf diseases are partly responsible for the failure of the trees to produce crops and for the early decline of the orchard. Leaf-spots are due to several different fungi, perhaps the most prominent of which is a species of *Phyllosticta*. A species of *Hendersonia* and the ordinary ' black rot ' fungus, *Sphœropsis malorum*, are found in in conjunction with some of the spots, and may be responsible for the injury in some cases. These leaf-diseases are largely prevented by application of Bordeaux mixture, and the foliage remains fresh and green long after unsprayed trees are defoliated." Two good applications of Bordeaux mixture are recommended, the first application about two or three weeks after the petals have fallen, and the second about seven weeks later.

It appears therefore, that in the States the injury caused by " leaf-spots," such as those shown in Plates XIV. and XVI., if not actually identical with them, is sufficiently serious to demand spraying. It is quite possible that with the constantly increasing acreage of apples in England, growers in this country will be obliged to have recourse regularly to the same measures. It is certain that in many districts last season it would have paid well to have sprayed against Apple " leaf-spots."

Cherry Leaf-Curl—a new Cherry Disease.

During the early part of the summer of 1907, a fungus disease, affecting cultivated sweet Cherries, which does not seem to have been hitherto recorded from England, was sent in to the College by several fruit-growers in Kent.

The first specimens were sent to me in June last from Ash, near Sandwich. The grower remarked that he had noticed it only on one tree during the season of 1906, but that by the next year it had spread " all over the orchard " ; he concluded by remarking : " I am afraid I shall lose the trees altogether unless I can find a remedy."

The disease was again sent in during June by Mr. L. Levy, of Borden Hall, by Sittingbourne. Mr. Levy wrote that his fruit-foreman spoke of the disease as " red rust," and that he had observed it appear regularly on certain trees year after year, also that it had spread considerably during the last season or two, with the result that a large number of fresh trees were now affected.

I then received the disease from Mr. A. O. Walker, F.L.S., of Ulcombe Place, near Maidstone. A note accompanied it stating that only one branch of the tree was affected, but that that " looked very bad."

The disease was also brought to me from the Horticultural College, at Swanley, where it had appeared on a number of young trees recently planted. In this case the disease was having a decidedly injurious effect upon the growth of the young trees, and if it had not been attended to, the disease would undoubtedly have ruined their growth.

I have also seen the disease in a number of Cherry Orchards in the neighbourhood of Pluckley and Charing, and in the neighbourhood of Canterbury, where it was seriously affecting the growth of some young trees of the " Noble " variety.

The general appearance of the affected branches can be seen in Plate XVIII. The disease causes the leaves of the Cherry to curl, as shown at *x*, and at this stage they become pinkish-red in colour. Soon a delicate whitish bloom is visible, spreading over the greater part of the under-surface of the leaf ; then the affected leaves turn brown, and very soon blacken and decay, and rot off. Frequently only a single leaf on a branch will show the disease, in other cases two or three leaves scattered here and there will be affected; while in rare cases most of the leaves on a branch will be attacked.

If a section is cut of a diseased leaf at the time when the whitish superficial "bloom" is visible, and placed under the microscope, we shall find, projecting from the under surface of the leaf, myriads of very minute sacs (*asci*), each containing four, six, or eight spores (*ascospores*). (See Fig 1). These little sacs are packed closely side by side, and extend continuously over the surface of the diseased part of the leaf, giving it the appearance of being covered with a delicate "bloom." When ripe, the *ascospores* escape from the sacs into the air, and are borne by the wind or insects to the leaves of other healthy branches, or to those of neighbouring trees, and are able at once to infect them, and so spread the disease.

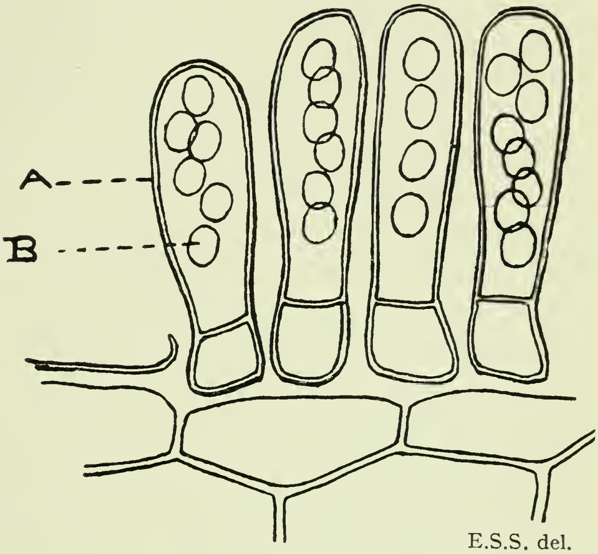

Fig. 1.
The fructification of *Exoascus minor*, the fungus which causes Cherry "Leaf-Curl."
A., an *ascus*; B, an ascospore.
Highly magnified.

The name of the fungus causing this disease is *Exoascus minor* Sadebeck. It is closely allied to *E. deformans* Fckl., which causes the "Leaf Curl" or "Blister" of the Peach, and also to *E. Cerasi*, the cause of the "Witches' Brooms" of the Cherry,—a disease which will be described below.

As Sadebeck noted,* when first describing *E. minor*, the rapid decay and rotting away of the affected leaves are due to a large extent to the fact that various saprophytic "moulds" and other organisms are able to obtain free entrance into the inner tissues of the leaf after the cuticle has been destroyed by the serried ranks of *asci* breaking through it.

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* *Kritische Untersuch. ueber die durch Taphrina-Arten hervorgebrachten Baumkrankh.* (Jahrb. Hamburgisch. Wissenschaftl. Anst. viii., 24 (1890).

The spawn (*mycelium*) of the present fungus hibernates, that is, passes the winter, in the buds of the Cherry, and then in the spring grows forth into the young leaves, causing them to curl and become more or less wrinkled. Sadebeck notes that these leaves have an odour of cumarin—the scent of new-mown hay. The fungus then forms its fructification, consisting of *asci* and *ascospores*, on the under surface of the leaf, as described above, while the spawn grows along in the wood and into the new buds as they are formed, there to wait until, in the following season, they open out into the new leaves, which will then in their turn be attacked.

In large old cherry trees it is seldom that more than a few branches are attacked, and the damage done is not often serious. But in the case of young trees, where it is necessary that all the wood formed should be healthy in order to produce a well-shaped tree, the present disease may become a serious pest. A badly attacked young tree, if not attended to, will be permanently ruined, through the annual production of shoots bearing a number of diseased leaves which soon drop off and so cause the growth of the shoot to be arrested.

The disease can be cured by pruning. As the spawn of the fungus is perennial, living on from year to year in the buds and young wood, it is absolutely necessary to cut off each affected branch well below the last diseased leaf. The spawn does not extend backwards, or downwards, in the lower main branches or the stem, consequently the pruning will completely remove the disease. It is well, however, to spray during the first season with Bordeaux mixture (using 4 lbs. copper sulphate, 4 lbs. quicklime, 50 gallons water) at the time when the leaves are just expanded. Severe pruning on these lines, and spraying as directed, will restore to complete health in a single season cherry trees which have been long suffering from the present disease.

As above mentioned, it does not appear that the present disease has been hitherto recorded as occurring in this country. Possibly it has been confused with the " Witches' Broom " disease caused by *E. Cerasi*, since in both cases the leaves on the affected shoots turn a pinkish or carmine-red colour. *E. minor* is distinguished from *E. Cerasi* by the fact that it attacks only the leaves, never irritating the shoots so as to cause the formation of a "Witches' Broom." In this respect *E. minor* is similar to *E. deformans*, which causes Peach "Leaf Curl." Further, the *asci* of *E. minor* are smaller, being 30-35 μ. long, and 6-8 μ. wide ; they contain larger, oval *ascospores*, 6-7 μ. by 5 μ. *E. Cerasi* causes the production of large "Witches' Brooms" ; and forms longer and narrower *asci* 35-50 μ. long, and only 5-7 μ. wide ; the *ascospores* are smaller and roundish, measuring 3-5 μ.

E. minor was first described by Sadebeck in 1890, as attacking "single shoots or shoot systems of *Prunus Chamœcerasus*, Jacq,' near Hamburg, Germany. It does not hitherto seem to have been recorded from elsewhere. Tubeuf* states that it has been found on *P. Cerasus*.

We will turn now to the disease produced by *E. Cerasi*. This is what is known as the "Witches' Broom" of the cherry, and occurs not uncommonly in cherry orchards in England. In some parts of Kent I have heard it called "Bull wood" or "Bull branch," in other parts "Buck-wood" or "Buck branch." In France it is called "Balai du Sorcière," and in Germany "Hexenbesen."

The cherry tree when attacked exhibits a curious malformation among the branches, so that at a distance it looks somewhat as though a bunch of mistletoe were growing there. At the place attacked a number of long branches, close together, develop, growing out in a tufted manner as it were from a single point, and thus forming a "broom"-like growth among the branches, in the middle, or towards the outside, of the tree. The branches of the "broom" are frequently four to five times as thick as the surrounding healthy ones. This abnormal thickness is due to the irritation caused by the fungus spawn living in the wood. The whole of the abnormal growth, resulting in the formation of a "Witches' Broom" is due to the attacks of the fungus *E. Cerasi*. The shoots composing the "broom" remain completely barren, never producing any flowers. The disease is most apparent in the spring, at the time of the blossoming of the cherry, because then the diseased branches forming the "broom" break out precociously into leaf—as is shown in Plate XIX., while the rest of the branches are covered with blossom. The "brooms" in a tree become consequently very conspicuous, appearing as little green bushes, as it were, in the midst of the white blossom-covered branches.

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* Tubeuf, "Diseases of Plants," p. 164. (English Translation.)

As the leaves on the diseased branches unfold, they turn to a carmine-red colour. If at this stage a branch is cut off, it exhales after a little time a sweet smell, like that of woodruff—due to the presence of cumarin. Normal healthy shoots do not behave thus. Soon a whitish "bloom" begins to spread over the under surface of the leaves on the diseased branches. This "bloom" is in reality composed of a serried mass of naked asci breaking through the cuticle and projecting from the under surface of the leaf—exactly as is the case of the fructification of *E. minor* described above. By the time the "bloom" appears, the leaves on the surrounding healthy shoots are just expanding, and are thus exposed to infection by the *ascospores* as these escape from the *asci* on the leaves on the diseased shoots. We see, then, the reason for the precocious unfolding of the buds on the shoots of the "broom," and the important part it plays in the life-history of the fungus.

The *ascospores* on reaching a healthy leaf infect it at once, and the resulting spawn grows down the leaf-stalk and penetrates into the wood. The spawn continues to grow forward into the young wood, which, as a result of being attacked, becomes abnormally thickened and lengthened, and, further, develops no fruit buds—in other words, becomes the starting place of a new "broom."

There are usually several "brooms" formed in a diseased tree, and the disease invariably appears on these year after year, even if the "brooms" do not increase in number. The damage done is appreciable; in the first place the mass of branches forming the "broom" is so much absolutely barren wood; in the second place, the "brooms" in their vigorous growth use up a good deal of food-material which should go to the making or ripening of healthy wood.

Now, the spawn of this fungus does not extend backwards (downwards) into the tree; consequently if all the "brooms" are completely cut out of a cherry tree, that tree stands completely healthy again. If, however, there are trees with "Witches' Brooms" in the neighbourhood, then it is necessary to spray with Bordeaux mixture (as described above) at the time when the leaves are just unfolding, as otherwise they will be liable to be infected by the air-borne, or insect-borne, *ascospores*.

This disease, like the Cherry Leaf Scorch, is one for which the co-operation of fruit growers is required before it can be entirely exterminated throughout a district. I have repeatedly seen a number of good cherry orchards situated close together all suffering from this disease, the various owners not having thought it worth while to cut out the " brooms," which have in consequence increased from year to year. Indeed many growers seem to look upon the malformed growth of the branches forming the " broom " as something inevitably connected with the age, or nature, of the tree, attributing it often to the action of " physiological " causes due to some fault of soil or cultivation, whereas it is entirely a fungus disease, and one which can easily be cured. The " brooms " are best cut out in the winter, at any time between October and February. They should always be removed and burnt before the fructification of the fungus appears.

A "Leaf-spot" Disease of the Chrysanthemum.

In 1902, Dr. M. C. Cooke, in his articles on " Pests of the Flower Garden " (*Journal of the Royal Horticultural Society*, vol. xxvii., p. 373), wrote :—"It will be well to be guarded against the occurrence of ' leaf spot ' on Chrysanthemums, as some three or four exotic species are already known. The ringed brown spot (*Septoria chrysanthemi*) has apparently been confined to Italy. This is the most essential to be watched of all, since it is European."

Last autumn, Mr. W. P. Bound, of the Gardens, Gatton Park, Reigate, Surrey, sent me a fungus disease which he had observed on his Chrysanthemums. Having had an opportunity of comparing this fungus with the authentic examples of *Septoria chrysanthemi* (Cav.) in the Herbarium of the Natural History Museum at South Kensington, I have ascertained that it is this species. Gardeners have, consequently, every reason now to be on their guard during the coming seasons against this Chrysanthemum leaf-spot, which appears to be a new disease so far as this country is concerned.

Mr. W. P. Bound writes that he had never observed the disease before last autumn, and reports as follows on its occurrence :—" The variety attacked was 'Letrier.' There was a general disfigurement of the plant, but the flower was not affected. The disease occurred also to a slight extent on 'Mrs. Thompson.' Both the above-named are late varieties. I feel pretty sure that we had it on some of the early-flowering varieties, but we took little notice of it at first. There were no signs of it till after the plants had been taken into the house."

The disease can be recognised by the presence of more or less rounded spots of varying size on the upper surface of the leaf (see Plate XX.). These spots soon turn to a dark reddish-brown, and these dark patches, which consist of diseased tissue, besides disfiguring the plant for ornamental purposes, render the leaves unable to carry on their proper functions ; and the plant in consequence becomes weakened in vitality. When the fungus produces its fructification, little black dots become visible scattered over the discoloured areas of the leaf. A section of a part of a diseased Chrysanthemum leaf, showing the fructification of the fungus, is drawn in Fig. 1. At *a* is shown the fructification, or " pycnidium," as it is called. The spores of the fungus are produced in countless numbers from the inner surface of this " pycnidium " ; in damp weather the spores may be seen escaping in hundreds from the mouth of the " pycnidium," as shown at *b*. At *c* three spores are shown more highly magnified. The size of the spores is 40-70 by 1.5-2μ.

The disease was first observed about 1890 in Italy, in the Botanic Gardens at Pavia and elsewhere. Briosi and Cavara state :—" We have, for several years in succession, observed this parasite in the autumn just when the Chrysanthemum is about to flower. The leaves which are affected by it, besides bearing brown patches, become crumpled at the margins, and fall prematurely."

In the United States Dr. Halsted writes of the disease as follows* :—" A blight has been quite prevalent upon the leaves of the Chrysanthemum, blotching them with brown until they wither and fall away. Moisture favours the development of these spots very greatly. Some varieties seem to be more subject to the blight than others, but probably all will take it when the conditions are most favourable and the spores are present. The same fungus was found by Prof. Beach at the Geneva (New York) Station on the foliage of greenhouse Chrysanthemums." Prof. Beach writes of the disease as follows:—It first appears in small brown spots, which increase in size and number until the leaf tissue dies and the foliage drops off. In badly-diseased plants nearly all the leaves wither and fall away. During the past year (1894) the Septoria has become more or less common on cultivated Chrysanthemums, and will likely prove one of the troublesome species of fungi. Experiments with fungicides for this pest have been carried out at the Geneva Station, and it is recommended, after the removal and burning of the spotted leaves, to cover the remaining foliage with Bordeaux mixture. It is said that 'five or six applications will

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* Report of the Royal Botanical Department of the New Jersey Agricultural College Experimental Station, 1891, p. 298, and 1894, p. 363.

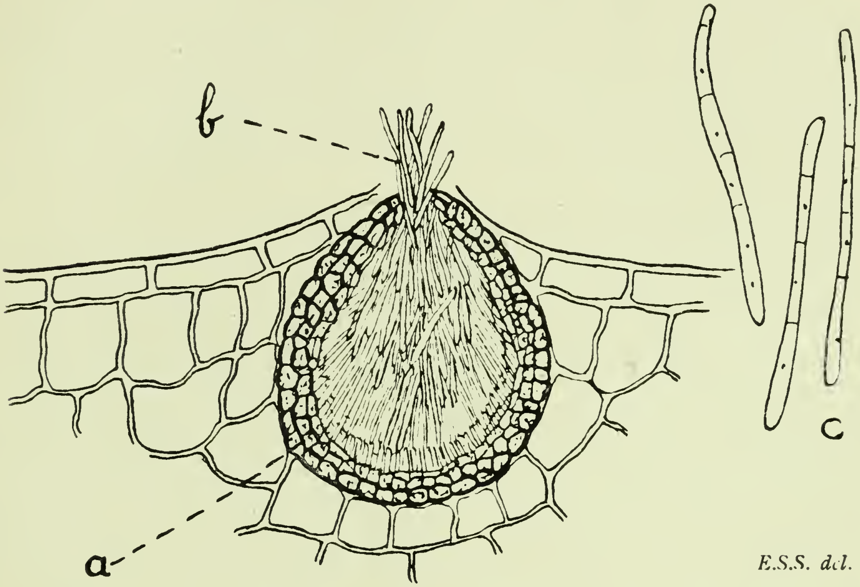

Fig. 1.

Fructification of *Septoria chrysanthemella*; highly magnified.

a, a *pycnidium*, in section; *b*, spores; *c*, three spores, more highly magnified.

usually be sufficient to keep the foliage covered, especially if soap is used.' The following formula for the Bordeaux mixture is given :—Dissolve two pounds of copper sulphate (bluestone) in water, add whitewash made of one and a half pounds of fresh-slaked lime, and dilute to twenty-two gallons of water ; then add enough soap to form a suds."

In Bulletin 121 of the Ohio Agricultural Experiment Station, it is stated —" Leaf-spot (*Septoria chrysanthemi*) is frequently a disfiguring disease in the earlier growth of the plant. For indoor treatment a copper sulphate solution (one pound to fifty gallons of water) will prove available. More applications will be required, but the foliage will not be rendered unsightly as with Bordeaux mixture which, however, may be applied in full strength." The time here recommended for applying the fungicide is first about July 1st, with a second application two weeks later, and similarly a third if necessary.

The disease is noted also in the *Report of the Maryland State Horticultural Society*, vol. iv., 1902.

On the Continent the disease is becoming prevalent. It was recorded from greenhouses in Copenhagen in 1897, and is now known from a number of places in Italy and Germany, In October, 1904, October 1905, and August 1906, it occurred in the form of an epidemic in nurseries in Berlin. Last year it was recorded* from Bohemia, in greenhouses, with the following note :—" The fungus is a dangerous parasite, especially in glass houses, where it soon attacks the majority of the leaves and causes them to fall."

Prof. Magnus,† in a recent article, has pointed out that correct name for the present fungus is *Septoria chrysanthemella*, Sacc.

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* Hedwigia, xlvi., p. 294.

† "Ueber die Benennung der Septoria auf Chrysanthemum indicum." (Ber. Deutsch. Bot. Gesellsch. xxv., 299 (1907).

" Fruit-growing, and the Conditions under which it may Thrive."*

"The title of my paper covers so wide a field that I need scarcely apologise for saying that I wish to confine myself to quite a small portion of it. It is obvious that one of the fundamental conditions under which fruit-growing can thrive to the full is a fair system of land tenure—the tenant farmer will be shy of planting up the best orchards and plantations in the absence of adequate compensation on quitting the farm. Another essential condition for the full development of the fruit industry is that the grower shall be able to obtain fair railway rates, and also the transmission of his fruit without the shirking of responsibilities on the part of railway companies.

" But such points are excluded from present consideration, and I must pass to the actual growing of the fruit. Here again all the various questions as to the best kinds of fruit to grow, and how to plant, prune and manure them must also be passed over.

" The point on which I wish to dwell on this occasion is that the fruit which is grown, if it is to be permanently profitable, *must be free from disease.* The remarks I have to make will be confined almost entirely to this point, *viz.*, that one of the essential conditions under which fruit-growing can thrive is that clean fruit is grown on healthy trees or bushes.

" This statement may seem at first sight almost a commonplace, and of such obvious practical importance that no commercial fruit-grower would be ever likely to neglect the point. But it is not so. Take the case of the most generally grown fruit, *viz.*, the apple. Look at the diseased, " scabby," misshapen English apples so commonly offered for sale in our provincial towns, and contrast them with the clean, well-grown, imported apples, which had been grown practically free from all diseases by adopting the modern methods of spraying. I am not, of course, referring to the pick of English apples, which, it appears, will always remain the finest in the world. But it is a fact that the average quality of our apples is nothing like so high as it should be.

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* Paper read at a Meeting of the Farmers' Club, London, May 4th, 1908.

"A fact which I learnt on taking up my post two years ago as mycologist to Wye College, made a deep impression on me. I learnt that a consignment of apples from Kent, affected with the fungus disease known as 'Black Spot' or 'Scab' to no greater extent than is usual with a considerable proportion of English apples, was exported to Cape Town, but was refused admittance at the port of entry by the authorities there on the look-out for this disease.

"Again, there are hundreds of tons of little, dried-up, cracked, scabby pears produced in English orchards, whereas by systematic spraying these pears could be grown large, smooth-skinned, and without a blemish.

"It is my firm conviction that it will not be until the fruit-grower in England has learnt two lessons from his Colonial and American competitors that two essential conditions will obtain under which fruit-growing can thrive to the full extent in this country.

"The first lesson he must learn is how to keep his fruit free from diseases caused by fungi and insects. Action in two directions is necessary. *First,* the grower must himself carry out systematic remedial measures against certain ever-present diseases to prevent them gaining the upper hand; spraying must become as regular an operation each season as the cultivation of the land. Further, growers in a district must combine to stamp out certain diseases which have become epidemic in that district. *Secondly,* growers must obtain legislative assistance from the State in order to stamp out or control a certain class of diseases.

"I should like to illustrate my point by taking actual examples in each class.

"Let us consider first the fungus disease known as apple 'scab' or 'black spot.'* To the increasing and unchecked prevalence of this disease in recent years may be attributed almost entirely the thoroughly inferior appearance of the average English apple on sale in provincial towns as compared with that of the imported apple.

"Now this disease can be easily and cheaply controlled by the

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* An illustrated Leaflet on this disease can be obtained an application to the Secretary.

English grower if he learns the modern methods of spraying. The life-history of the apple scab fungus is as follows :—The 'black spot' or 'scab' caused by the growth of the fungus on the fruit is, as a rule, the only sign of the disease perceived by the grower, In severe attacks the grower notices that the apples, when young. become so diseased, that they either crack and drop off, or grow out into one-sided, misshapen, worthless apples; in less severe attacks, the grower recognises the pest as 'black spots' or little 'scabs' on the ripe apple, causing the market price to be greatly depreciated. But the average grower does not know that the dark brown, "sooty" spots or streaks on the *leaves* are caused by the same pest, and that it is on the leaves that this fungus increases so rapidly and produces millions of spores, which infect the apples; and, further, that by spraying the leaves and keeping them healthy he can grow a perfectly clean crop. There is another very important fact, of which the grower is usually entirely ignorant, *viz.*, that this same pest is able to live on the *young wood* of certain varieties of apples from year to year, so that it is frequently the case that orchards and plantations which have suffered from 'scab' for several years are never wholly free from the fungus at any time of the year. It is only recently that this fact has been ascertained. During 1906, a number of reports from fruit-growers in Kent were received at Wye College, telling of the increasing damage that was being caused in the same orchard year after year by apple 'scab.' On joining the staff of Wye College that year, I investigated several of the worst-affected orchards in the county, and ascertained that in nearly every case the pest existed in a stage not hitherto recognised as occurring in this country, *viz.*, on the young wood. The fact is of great practical importance, because the grower is now able by pruning or by applying a strong winter-wash to the "scab"-infested wood, to remove what is often the primary source of infection each spring.

"By spraying the leaves with the fungicide known as Bordeaux mixture* just before and just after the period of blossoming, followed if necessary, by a third spraying a fortnight or so later—and in cases where a quantity of scab-diseased wood exists, by spraying in winter with copper sulphate—a grower can reckon on growing, season after season, a crop of apples perfectly free from 'scab' on trees which have been producing "scabby" apples for many years previously.

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* A Leaflet giving directions for making Bordeaux mixture can be obtained on application to the Secretary.

"I have mentioned the above disease in some detail, because it illustrates how a grower can get rid of a disease which has been depreciating the value of his crop, often by hundreds of pounds a year, if he learns the main facts as to the life-history of the pest, and the right methods of dealing with it by spraying.

"The use of home-made Bordeaux mixture is gradually increasing now, season by season, with the result that the growers using it fear the 'scab' less and less. I have received many letters from fruit-growers in Kent, testifying to the value of spraying with this fungicide—the statement being frequently made, that after the first season's spraying the crop of apples had come clean from 'scab.' In some cases this clean crop was obtained for the first time in the memory of men who had been working among the fruit for many years. Growers who have sprayed have told me that their neighbours, having seen the result, have decided to start spraying their own fruit with Bordeaux mixture the next season. I have known apple orchards, composed of varieties (such as Wellington and Northern Greening) which are very susceptible to 'scab,' from which, until the grower had recourse to spraying, the crop was of so inferior a quality that it was frequently sent to market in bags; in the first season when Bordeaux mixture was used, the whole of the crop was of such excellent quality that it was carefully graded before being packed in boxes for the market—the only 'scabby' fruit in the orchard being that on a few unsprayed trees which had been left as a 'control.'

"With regard to insect diseases, the grower can now, by spraying with arsenical washes, entirely prevent the defoliation of his fruit trees by caterpillars. As a well-known fruit-grower in Kent said to me last season: 'We don't fear caterpillars any more, now that we have got hold of arsenate of lead.' This knowledge, however, is as yet far from general, and it is still a common sight to see trees stripped bare of their leaves by caterpillars.

"These arsenical washes can be mixed quite safely with Bordeaux mixture, with the result that certain fungus and insect diseases are entirely prevented by the use of this combined insecticide and fungicide.

"I should like to mention one other fungus disease in some detail, because it shows clearly the educational advance in the knowledge of diseases and their cause and cure that has yet to be made by the average fruit-grower before the industry of fruit-growing can thrive to the full in this country. There is a fungus disease called 'Brown Rot'*; it attacks the cherry, plum, apple, and pear. It is an extremely common pest, yet it is not too much to say that it is scarcely ever recognised by the English fruit-grower as a definite disease at all, the injury it inflicts being attributed to the action of frost at the time when the tree is in flower. As a matter of fact, it is the *spores* of the 'Brown Rot' fungus which attack and kill the actual flowers, and eventually enter and kill the wood. In Kent, this pest has been gradually wiping out the cultivation of acid cherries such as the Morello. Some kinds of sweet cherries, such as Governor Wood, are often attacked to such an extent that every year half or more of the crop is lost. And all the while no steps are taken by the grower to prevent the loss, because he is not even aware that any definite pest is attacking the trees. Yet this disease can be readily cured by spraying. In one of the demonstration spraying experiments carried out by Wye College, two thorough sprayings with Bordeaux mixture so checked the disease on some Flemish cherry trees badly affected with 'Brown Rot' that the sprayed trees yielded double the crop gathered from similar unsprayed trees.

"Another point in connection with the 'Brown Rot' disease, is that the fruit which is attacked and turned rotten, does not drop off, but to some extent remains hanging on the boughs through the winter until the following spring. On these old dried-up or 'mummified' fruits the fungus then develops myriads of *spores*; these spores are carried to the blossoms, and so the disease is re-started again for the season. Clusters of such 'mummified' fruits, covered with the *spores* of the fungus, are a common sight hanging on plum trees which have suffered from 'Brown Rot.' In the case of susceptible varieties of plums (such as Pond's Seedling), it is no uncommon thing for the present disease to destroy 25 per cent. of the crop, season after season, after the pest has once established itself. I remember well, in the first week after taking up my work in Kent, paying a visit to a grower who possessed some large plantations of plums. The time of year was February. This grower complained that in certain parts of the plantations the plums became rotten instead of ripening; also that much of the blossom turned brown and withered, instead of setting fruit, and that the trees showed an increasing quantity of dead wood —all of which made me suspect that 'Brown Rot' was at the bottom of the mischief. On my asking to see the plantations, the grower remarked that it was of no use visiting them then, as 'nothing was to be seen of the disease in winter.' I asked, however, to be allowed to walk through the plantations, and there I saw hanging on the branches of the trees hundreds of little bunches of 'mummified' plums (now little more than the stones of the plum), covered with the *spores* of the 'Brown Rot' fungus. On several trees there were over a dozen of such sources of disease. For season after season the disease had thus persisted visibly on the trees through the winter, although the grower had not the eyes to see it. Of course, all such rotten or 'mummified' fruit should be collected and burnt, or buried in quicklime. Growers in Kent are now gradually learning the cause of the damage done to their fruit trees by 'Brown Rot,' and taking steps to prevent it by spraying with Bordeaux mixture.

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* An illustrated Leaflet on this disease can be obtained on application to the Secretary.

"Now let us pass to the consideration of the class of diseases which require the co-operation of growers to stamp them out. We will take the disease known as 'Cherry-leaf Scorch.'* This is a disease which is seriously affecting the productiveness of a considerable acreage of cherry orchards in certain districts in Kent. In the great majority of cases nothing at all is being done, because the grower in most cases has been entirely ignorant of the real cause of the disease, attributing it to the action of an early frost in autumn, or, more vaguely, to 'poverty' of soil.

"The life-history of the fungus causing the disease is as follows:— The spawn of the fungus feeds on the leaves during the summer, and finally grows down into the leaf-stalk, producing there such injury that the leaves, when dead, remain firmly attached to the branch, instead of being thrown off in the autumn as healthy leaves are. The fungus persists in these dead leaves, and ejects from them in the following spring thousands of *spores*, which infect the young opening leaves. As a result of the injury to the leaves, the trees show a weak growth, and become eventually too weak to carry a crop.

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* An illustrated leaflet on this disease can be obtained on application to the Secretary.

"Now, since this disease attacks the leaves only (never penetrating into the wood), the dead leaves hanging on the trees remain the only source of infection. Consequently if, during the winter, they are systematically collected and burnt over the whole of an infected district, the disease will be stamped out. Such action, however, requires active co-operation among the fruit-growers of a district, since any orchard left untreated will be a source of certain infection to the surrounding ones. When this same disease, in 1880, affected the prosperity of certain cherry-growing districts in Prussia, the growers, assisted by the Government, exterminated the disease by carrying out the above measures. The expense of collecting the dead leaves from large trees severely attacked is, however, very considerable. I have lately shown by experiments that the disease can be controlled by spraying in the spring with Bordeaux mixture. But still, co-operation among growers will be required before the disease can be exterminated in a locality. For this purpose spraying must be carried out in all the orchards, as otherwise any grower who clears his own trees, while his neighbours do not, will have his trees constantly exposed to infection by *spores* blowing in from surrounding orchards.

"Among insect pests, the Codling Moth may be mentioned as one requiring co-operation before it can be driven out of a district.

Will fruit-growers in England in the future unite, district by district, to wage common war against certain fruit pests? I believe so. I hope that already in the formation of co-operative societies composed of energetic fruit-growers, such as the 'Yalding Farmers, Limited,' in Kent, we see the beginning of local associations of fruit-growers, which, among other work, will, by means of co-operation, clear their respective districts of certain pests. A light, portable engine, working a powerful spray pump, supplied with a number of leads and the modern type of nozzle, could, if worked co-operatively, clear a whole district of such pests as "Cherry-leaf Scorch" at a slight cost per acre.

"In the fight against fruit pests, research is required on the one hand, and on the other the carrying of the information acquired to the grower in a form in which he can both understand it and make practical use of it. Although fruit-growing is the only branch of agriculture which has shown continuous and marked progress in recent years, the Government continues to treat it with almost total neglect. We require a State Experiment Station on good fruit land, where experiments can be carried out in planting, pruning, grafting and manuring, and in testing new varieties; where research into the life-history of fruit pests can be carried out; and where also the practical work of testing sprays and spraying outfits is undertaken. There is urgent need now for scientific work in the chemical analysis of the various fungicides and insecticides, and especially in ascertaining to what extent fungicides and insecticides can be combined. Lecturers from the Station should be sent out to give the growers the information they require by means of illustrated lectures. On more than one occasion I have heard a grower say, after I have been showing by means of lantern slides (prepared from photographs) the characteristic signs which indicate the presence of fungus diseases, 'I have got every one of those diseases on my trees. I've seen them year after year, and never realised that they were the cause of my trees doing badly!' There should be demonstration spraying experiments at the Station; and also spraying experiments carried out co-operatively by the State and the grower in commercial fruit plantations under ordinary commercial conditions.

"The efforts made by the Board of Agriculture are seen in the publication of often very inferior leaflets, which, although distributed by the thousand to centres, and also sometimes to individuals, can be said to have practically no educational effect in the country. Some of the leaflets, indeed, are provided with illustrations of so poor a quality that they show absolutely nothing distinctive of any disease.

"We will pass now to a very important point, *viz.*, the consideration of those cases where State action is absolutely necessary if fruit-growing is to be given the conditions under which it may best thrive. It is obvious that if a new, dangerous, and infectious pest gets introduced into this country, it ought to be exterminated at once before it spreads. Since the matter concerns the industry of fruit-growing as a whole, the stamping out of the pest should be treated as a matter of national importance, and not as of merely local concern. There is the same need for legislative action by the State in order to stamp out any new infectious disease of plants of economic importance as there is for the control of rabies or swine fever or foot-and-mouth disease.

" It is only within the last year, however, that such legislative assistance was obtained on behalf of fruit-growers. It came about in this way. Since 1900, England has stood in constant danger of the introduction from Ireland or the Continent of the very destructive pest known as the American Gooseberry mildew.* In 1902, the Board of Agriculture inserted an utterly inadequate paragraph (giving no special warning) about the American Gooseberry mildew in one of their leaflets on another disease, but took no action, although their attention was constantly called to the danger. When the disease was actually found in England, in the autumn of 1906, many months passed before the Board could be made to understand how necessary it was that some legislative action should be taken at once against this new disease. The procrastination and lack of scientific methods shown by the Board brought, to quote Mr. Spencer Pickering's words (in the *Times* of December 28th, 1906), ' into glaring prominence the inadequacy of our Board of Agriculture to deal with the interests of the fruit industry.' It was not until July 4th, 1907—by which time the mildew was beginning to spread far and wide in certain districts in England—that the Bill known as the ' Destructive Insects and Pests Act ' was passed to give the Board the necessary legislative powers to deal with the disease.

" Now the ' Destructive Insects and Pests Act ' must be welcomed by fruit-growers as a sincere desire on the part of the Board to help the fruit industry. It is the first law passed in this country against fungus diseases. Under this important and far-reaching

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* An illustrated Leaflet on this disease can be obtained on application to the Secretary.

Act, not only can fruit pests already existing in the country be stamped out or controlled, but the importation of new fungus or insect pests can be prevented. This recognition of the necessity for State assistance in combating fruit pests—on which growers are obliged to spend thousands of pounds annually—marks a very important step forward.

"The most important work now for growers is to see that the Board use their new powers under this Act with wisdom and energy. The measures taken, if they are to be successful, must be scientific, practical, and economic. Further, it must never be forgotten, all compulsory measures must be framed on an equitable basis, so as to secure the energy and co-operation of the grower ; for without this the Board can accomplish little. The new work to be undertaken by the Board is largely of an educational nature, and progress must be slow, as those who possess intimate knowledge of the generally backward condition of fruit-growing in this country will readily admit. But if the measures taken are scientific, economic, and just, then progress, though slow, will be sure.

"Have the Board acted scientifically and wisely in the first steps they have taken under the new Act ? I think not. Recent events seem to show that the Board have become bewildered by the new powers suddenly conferred on them. Apparently destitute of a policy of their own, they have been spurred by various forces from outside to spasdomic and often contradictory action, until the commercial fruit-grower, harassed by vexatious as well as sometimes obviously impracticable demands, has become distrustful of, if not actually frightened at, their new activity.

"The main facts as to the state of affairs at present are as follows : The Board have taken action, so far, against but one pest, *viz.*, the American Gooseberry mildew. It is well to look into this case somewhat closely, because what has happened here may be repeated, unless growers combine to prevent it, when the Board take steps against other pests. This mildew, which is at present strictly confined to four centres of infection in this country, is a pest which, to quote the Board's own words, 'has rendered the cultivation of gooseberries unprofitable wherever it has appeared, and in some cases impossible.' The whole weight of scientific evidence shows that this is a disease which is so infectious and epidemic that all such remedial measures as spraying are either ineffectual or too expensive for the commercial fruit-grower. To quote again from the Board's own *Journal,* '. . . bushes which last winter were believed to be free from disease have become affected in spite of careful pruning, followed by regular spraying. It is clear that even pruning and spraying will not ensure immunity from the disease.'

"How have the Board proceeded against such a disease ?

"The first Order, issued in July, 1907, made the disease a notifiable one (under a penalty not exceeding £10) ; the grower was required 'to destroy immediately by burning or other effective method all diseased bushes.' *The payment of any compensation for the bushes compulsorily destroyed was left optional on the part of the local authority, which was required to provide the money out of the rates, as no Treasury grant was provided.*

"Now it must be remembered that gooseberry bushes only slightly affected with this mildew may continue to give a good crop for several years before the pest shows its full powers of destruction ; but during these years such bushes will constitute a centre of infection, because every summer the mildew will produce on them millions of summer-spores, which will blow about on the wind, and so spread the disease through the whole district. The compulsory destruction of slightly diseased bushes in full bearing must, therefore, be regarded to some extent as the destruction of private property for the public good, and therefore some compensation should be paid to the grower.

"The actual course of events followin the issue of the Order was as follows :—The County Councils in Worcestershire and Norfolk sent out notices ordering the destruction of diseased bushes, at the same time intimating that no compensation would be given. But the destruction of the bushes never took place. The growers protested, and both the County Councils and the Board of Agriculture feared to exert the necessary legal pressure in face of the protest. The deadlock continued through the summer of 1907, *during which time, of course, the mildew spread to a considerable extent in the various districts.*

"Deputations of growers from Wisbech and Evesham then urged the Board that if no compensation was to be allowed them, the first Order should be revoked, and a second Order issued, giving the grower the alternative of pruning and spraying diseased bushes, instead of destroying them. This change of policy, disastrous from the economic as well as the scientific standpoint, and diametrically opposed to the advice the Board themselves were giving at the time in their *Journal*, was adopted in the second Order, issued on December 10th, 1907, and still in force. When the disease broke out in England, instead of proceeding at once with the work of its certain eradication by the total destruction of affected bushes while the disease is dormant in the winter, the Board pursued a policy of procrastination during the winter of 1906-7, and adopted a useless compromise through the winter of 1907-8. It seems that the latter course was adopted because the Board have been too apathetic to work out a scheme under which assistance could be given to county funds by a grant from the Treasury, so that some compensation could be given to enable the necessary scientific measures to be taken for stamping out the disease.

" Anyone who is acquainted with the history of the spread of this disease in Europe since it was introduced from America a few years ago, and who has read in the foreign scientific journals of the devastation it has caused, must conclude that the Board are either blind to the extent of the present danger, or are shirking their responsibilities.

"Let us now take one or two points, and note the kind of information which the Board have lately been giving to fruit-growers.

In their first 'Memorandum,' in 1906, on the disease, the Board told growers to spray with Bordeaux mixture* in winter. On account of certain well-known facts in the life-history of this mildew, it was obvious that this advice was entirely unscientific, and, as I wrote at the time, 'growers who spray as directed will literally waste their money.'

" This official Memorandum was, of course, sent out through the country and copied into the provincial papers, and those growers who had confidence in the Board doubtless did spray with Bordeaux mixture in the winter—to the advantage of sellers of copper sulphate and to the detriment of their own pocket. A year later we find the Board making the following statement :—'The winter-stage of the fungus is so well protected that none of the sprays in ordinary use affect it, and there is very little chance that any kind of spray would prove effectual.' The latter advice is perfectly true, and should have been given a year before, instead of the inaccurate advice then published through the country.*

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* It may be remarked that in the advice given as to the making of Bordeaux mixture neither the formula nor the manner of mixing the ingredients are in accordance with present scientific knowledge.

"Take another point—another blunder that might have led to very serious waste of the growers' money. In the first 'Gooseberry-mildew Order,' issued in July, 1907, growers were actually required (under a penalty) to spray thoroughly the site of every bush with a very strong solution of copper sulphate. The practical grower soon recognised the foolishness of this piece of advice ; a Wisbech grower soon pointed out publicly that 'this dressing is altogether ridiculous, since it would cost £40 an acre.' This grower added, pertinently, he 'would grow twitch preferably.' In the case of the present disease, the proper fungicide for treating the ground is the comparatively inexpensive solution of potassium sulphide—a piece of knowledge the Board ought certainly to have possessed, since this fungicide has been employed for this very purpose for some years now by the Swedish Government. Five months later we find the Board realising their mistake, and ordering potassium sulphide to be used in the place of copper sulphate.

"In recent numbers of the *Journal of the Board of Agriculture*, we find a number of pseudo-scientific statements† which ought never to have appeared. Growers are told that 'burying the surface soil' of affected plantations will 'considerably lessen the chances of fresh infection"—a statement for which there is not the slightest scientific evidence. Also, that dressing the soil with kainit will kill the germinating spores of the mildew. But as the spores do not germinate until they reach the leaves, it can be seen that this advice, if taken, will be to the advantage again, not of the grower, but of the seller of kainit. Such statements as these are just what might have emanated from some clerk masquerading as a scientific expert on plant diseases. To give seriously in their official journal such idle suggestions as the digging of the surface soil, or sowing the ground with kainit, as measures of any real value in the fight against a newly arrived and highly infectious fruit pest, which at present is strictly localised in this country, marks surely the lowest ebb of intelligence at which a Board of Agriculture can arrive.

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* It is worth noting—as an instance of the unscientific nature of much of the advice at present given by the State to growers—that the Board of Agriculture in Ireland have been giving since March, 1906, the advice to growers to spray affected bushes with a caustic spray,—a perfectly useless spray for this purpose.

† In the coloured plate given in the December number of the Board's *Journal*, the figure purporting to show the winter-fruit of the mildew on an enlarged scale bears not the slightest resemblance to the American Gooseberry Mildew, although it does recall somewhat another fungus which is sometimes found on gooseberry shoots. Any student in mycology on being shown this Figure 4 in this plate would, I undertake to say, unhesitatingly affirm that it resembles no stage of the mildew known to science.

"Finally, let us consider, since the matter is one of great importance to the fruit industry, the manner in which the Board have dealt with the question of stopping the importation of the mildew into this country. It is a story of repeated procrastination. In 1901, the Board of Agriculture—as the reference in one of their leaflets shows—knew of the existence of the disease as close to England as Ireland. I repeatedly, in 1905 and 1906, in the horticultural press, drew their attention to the necessity of stopping the importation of diseased bushes. In the *Journal of the South-Eastern Agricultural College,* in July, 1907, I again emphasised the point. Even when, finally, on July 4th, 1907, the Board acquired full legal powers to control importation of bushes, and when one would have thought immediate action would have been taken—since the Board had been considering the matter for over a year—it was not until December 14th, 1907, that 'The American Gooseberry Mildew (Prohibition of Importation of Bushes) Order' placed any restriction on the importation of the disease. Thus, through the apathy of the Board, gooseberry bushes, in so mecases bringing the American Gooseberry Mildew into England from the Continent, were freely imported during the winters of 1905-6 and 1906-7, and for the first part of 1907-8. The official excuse for the delay was that 'the work could have not been done sooner.' Accepting the answer, I would point out that remembering that the whole essence of the scientific treatment of new fruit-pests lies in immediate action, no greater proof could be given of the correctness of Mr. Spencer Pickering's opinion that the present organisation of the Board ‘brings into glaring prominence its inadequacy to deal with the interests of the fruit industry.’

“What likelihood is there, with the present organisation at the Board of the prevention of the importation at some time or other of disastrous and infectious fruit pests such as the ‘Black Knot’ of the plum, or the ‘Fire Blight’ of the pear (which has made a desert of large areas of pear orchards in California); or if any of these diseases are imported, of their being stamped out at once? I am afraid, none whatever.

“I wish to draw your earnest attention to the fact that fruit-growers are not receiving the attention which is due to so important an industry, and which farmers engaged in stock-breeding already receive. In the recent outbreak of foot-and-mouth disease, the action of the Board in delaying for one month before issuing an Order prohibiting the importation of hay and straw, received very severe criticism in the House of Commons at the hands of Mr. Chaplin. For a similar Order to protect their interests fruit-growers have had to wait, not one month, but for several years.

“Reviewing the evidence given above of inefficiency and procrastination on the part of our Board of Agriculture the question occurs at once, ‘What is the necessary reform?’ What is the remedy for this state of things which, if continued, must make the Board of Agriculture in its new work of dealing with fruit pests the laughing-stock of those countries which, like the United States, are properly equipped with an official staff of scientific and practical men. It is obvious that to allow inefficiency and want of knowledge in an Intelligence Department dealing with any branch of agriculture—and fruit-growing has been described as the only branch of agriculture in England which has shown continuous progress in recent years—must always be the most expensive blunder that any nation can make. To illustrate how completely out of touch the Board are at present with the needs of the practical fruit-grower the fact may be mentioned that there exists no leaflet available for distribution on spraying machinery and sprays.

“The remedy could be found perhaps in carrying out the first Recommendation made by the Departmental Committee appointed by Lord Onslow in 1905 to inquire into the condition of the fruit industry of this country, *viz.*, ‘that a special Sub-Department of the Board of Agriculture and Fisheries be established to deal with matters connected with the fruit industry.'

" Stock-owners have united and obtained State assistance in fighting infectious animal diseases. Fruit-growers must do the same. The necessary reform at the Board of Agriculture will not be obtained until there is a strong and united fruit-growers' association pressing forward its claims for State assistance. As a member of its Executive Council, I should like to take this opportunity of bringing to your notice the 'National Fruit-Growers' Federation.' It was due largely to the energy of this body that the first piece of legislation framed especially to protect the interests of fruit-growers, *viz.*, the 'Destructive Insects and Pests Act' was obtained from the Board last year. Among the main objects of the Federation is the work of urging upon the Government the necessity of creating a Sub-Department to deal with matters connected with the fruit industry.

" What is required now is a public opinion educated to see the national importance of a thriving fruit industry carried on both on large fruit farms as well as on small holdings ; it would then demand thorough reform and reorganisation of the Board until the best scientific and practical advice as well as the necessary legislative assistance is available for fruit-growers in this country. The more fortunate American fruit-grower obtains this information at the present day from the various Bureaus of Information existing in the United States Department of Agriculture, with its numerous staff of highly trained men specially qualified to assist the commercial fruit-grower.

"Then, continuing to do all that can be done to ward off diseases from his crops, the grower must learn another lesson from his American and Colonial competitor. I hope to see in the near future the formation in England of local Fruit-growers' Associations or Unions similar to those we find in other countries. The members of such associations are required to grow fruit of high quality, which is graded and packed in an expert manner, and—a most important point—sent to market distinctively and conspicuously labelled. As this label becomes known as a guarantee of uniform high quality fruit the association's produce is looked for both on the market and by the public and consequently commands a high price. If the present system of selling fruit in the big markets gives no advantage to the grower who is improving the quality of his fruit, it is clear it must give way to a better. If I may be permitted to do so, I would advise English fruit-growers to read the 'Regulations' of such an association as the 'Hood River Apple-growers' Union' of Oregon, U.S.A., with the example they set of splendid energy and mutual co-operation.* In 1906, this association, as an experiment, sent over to England a small consignment of apples selling in Oregon at 3s. 6d. a box. On being sold in England each box returned, after the payment of all expenses, 5s. 6d. to the grower. But it must be carefully remembered that results such as these are only obtainable with clean, sound fruit, properly graded, packed and marketed.

"To summarise the foregoing I would draw the earnest attention of fruit-growers to the necessity of their taking active measures to grow their fruit as free from disease as it is possible. It does not pay to grow diseased fruit on unhealthy trees; in all the important fruit-growing countries spraying has long passed the experimental stage, and it has been conclusively demonstrated that it pays—and pays well—to keep fruit clean by systematic spraying. The grower must fight against the various diseases both single-handed and by combined action. He needs also State assistance; and this, in my opinion, he will never obtain until there is created at the Board of Agriculture a special Sub-Department to deal with all matters connected with the fruit industry. Then, fully equipped in the warfare against fungus and insect pests, and able to grow clean fruit of high quality season after season, let the grower pay attention to the methods of grading, packing, and marketing adopted in other countries.

"It is my firm belief that the above are among the essential conditions which must be fulfilled before fruit-growing can thrive to the fullest extent in this country."

A lengthy discussion by members of the Club and visitors followed the reading of the above paper. This, for reasons of space, cannot be given here; it will be found in the Journal of the Farmers' Club, for April, 1908, pp. 707 to 724.

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* A copy of these Regulations can be obtained, on loan, on application to the Librarian.

In replying to the various points touched upon in the discussion, Mr. E. S. Salmon said :—" There has been some difference of opinion expressed as to the value of spraying. Now I think that this is to be explained, because there is spraying—*and spraying*. Unscientific spraying is worse than useless. For instance, to take a common syringe—or a hop-washer—and, using an unsuitable nozzle, to deluge fruit trees with some proprietary spray-fluid, is not spraying at all in the right use of the word. Proper machinery and proper sprays are absolutely essential. I entirely sympathise with the view that has been expressed that we do not want to see the fruit-grower become a Klondyke, out of which the various proprietors of spray-fluids dig their gold. That was why I have emphasised the great importance of the fungicide known as Bordeaux mixture. It is the best of all fungicides ; it is very cheap, and the grower can easily make it. The fruit-grower, as a member present has remarked, is not that ignorant person he is often supposed to be, and because of this I am absolutely sure that the average fruit-grower is able to make his own fungicide and insecticide, and thereby to save the often considerable sum of money expended in the purchase of the many useless spray-fluids which are now being so extensively advertised.

" A member present has said that he thinks I may have exaggerated in my remarks about Pear ' Scab.' My remarks were not meant to convey the impression—which, perhaps, this gentleman gathered—that *all* ' rough, cracked ' pears were due to attacks of ' scab,' and so could be cured by spraying. Of course, peculiarities of soil, and cultural and weather conditions will cause pears to crack or become distorted. But I still think I am within the mark in saying that hundreds of tons of ' scabby ' pears are grown. ' Scab '—true ' scab '—cannot come in the absence of a definite fungus, and according to my experience in going through pear plantations and orchards, it is the exception to find the young wood of many varieties of the pear free from this ' scab ' fungus.

" The remaining point on which I should like to touch is to emphasise again my conviction that only a State Fruit Department can adequately protect the interests of the fruit industry. We must remember that it is not only in the United States that proper State assistance is given to the fruit industry, but that all the chief fruit-growing countries, including our own Colonies, have now recognised the necessity of taking this course. In all these countries a special State Department, properly equipped on both the scientific and practical sides, has the duty of looking after the interests of fruit-growers. One of the results is that a system of inspection at the ports has long been in vogue to prevent the entrance of new fruit pests into the country. If such had been the case in England, it is more than probable that we should have kept out of the country not only the American Gooseberry Mildew which is now beginning to cost the country thousands of pounds, but also a new and very serious potato disease (the 'warty disease' or 'black scab'), which has found its way into Britain. As an illustration of the energy shown abroad, it may be mentioned that the State Horticultural Department in Australia are now enabled to enter any orchard known to be the breeding-place of certain pests, and if the owner refuses to act, to carry out the necessary spraying and other remedial measures themselves, and then to recover from the grower in the civil courts the cost of doing the work. In all these countries we find a State Experimental Station, able to give first-hand and reliable information to fruit-growers on the most important points connected with the fruit industry.

"England stands alone in the studied neglect by the State of the fruit-growing industry. It is true that in this country, in 1903, evidence was collected at great trouble and expense from practical men from all over England. A Departmental Committee was appointed by the Board of Agriculture to receive the evidence and nominally to advise it what steps to take. The establishment of a special Fruit Department at the Board of Agriculture, and a State Experimental Station, stood first among the Recommendations of this Committee. But by the deliberate neglect of the advice thus obtained, the Board have reduced the proceedings to a farce. It is obvious that until fruit-growers in this country can secure the necessary State attention to scientific and practical points connected with their industry, they will remain severely handicapped in comparison with growers of other countries."

The "Rhizoctonia" Disease of Seakale.

By E. S. Salmon and T. E. Crompton.

In the autumn of 1906, serious damage to various kitchen-garden crops was noticed in the vegetable department of the College. This damage proved to be due to the attacks of the fungus *Rhizoctonia violacea,* a root—or stem—parasite, capable of attacking a very wide range of host plants. This fungus had not been noticed before in the gardens, but on raising the root crops it was found that during the season it had attacked several crops. The disease had done considerable damage to the Salsify, reducing the crop by fully one half ; the fungus had also attacked parsnips and carrots, and to a very serious extent the Sea-kale,—the crowns of which (required for the next year's forcing) were rendered useless to the extent of nearly half the crop. Many of the diseased crowns had rotted away.

The fungus, *Rhizoctonia,* is seen as a felted mass of violet spawn, or *mycelium,* adhering closely to the surface of the root, and forming conspicuous violet or purplish patches. Plates XXI. to XXIII. The threads (*hyphae*) of the spawn are very characteristic in appearance when seen under the microscope ; they are violet or purplish in colour, rather thick, and branched rather frequently at right angles. Scattered about over the spawn, or sometimes densely clustered, are usually to be found numerous, small, firm, violet bodies, appearing to the naked eye as minute round specks not unlike the heads of very small pins. These bodies are called *sclerotia,* and are, in fact, little globular masses of the spawn in a resting condition. They are composed throughout of densely interwoven *hyphae,* compacted into practically a solid mass of tissue. A microscopic section through one of these *sclerotia* shows at the base a mass of *hyphae* passing right into the tissue of the host-plant (see Plates XXIV. and XXV.), and it is thus that the host is attacked, and the necessary nourishment obtained by the fungus. Decay of the tissues of the host-plant ultimately sets in over the affected areas, and in severe cases of attack the whole, or at any rate, a large area, of the root or stock rots away, either before or after the plants are stored. The *sclerotia* may be looked upon as carrying out the function of winter spores, since they are capable of remaining dormant for a long period, being very resistant to cold, drought or other unfavourable conditions. Then, when suitable conditions again obtain, the *sclerotia* grow out into the ordinary vegetative spawn of the fungus, which extends through the soil, attacking various plants as it reaches them.

So serious were the effects of the disease on the sea-kale that it was decided to try various remedial measures during the season of 1907. The recurrence of the disease, if no steps were taken, was practically a certainty; since, in the first place, some of the cuttings used (which were all taken from the crop previously grown) had, in all probability, borne patches of the fungus (as in Plate XXIII.), since it occurred so plentifully on most of the roots; and, secondly, the position of the sea-kale bed being required to be the same, there was a strong probability, if not a certainty, that the soil was infected with *sclerotia* and, possibly, growing spawn. It was therefore decided to treat portions of the bed with various soil fungicides. Just before the planting of the cuttings in March, 1907, the bed was divided up into eleven plots. The size of each plot was 19 feet by 9 feet, with the exception of plots 2, 6 and 7, which measured 9 ft. 6 in. by 9 feet, and plot 3, which measured 28 feet 6 in. by 9 feet. The sea-kale was planted in rows, the cuttings being 18 in. apart in the row. The plots received the following treatment:—

Plot 1. Copper sulphate solution, 1 lb. to 1 gallon water; 40 gallons applied.
Plot 2. Saturated solution of iron sulphate, with 1 per cent. sulphuric acid; 20 gallons applied.
Plot 3. Control plot; no treatment.
Plot 4. Mercuric chloride (corrosive sublimate), 1 oz. to 8 gallons water; 40 gallons applied.
Plot 5. Phenol (carbolic acid), 1 oz. to 1 gall. water; 40 gallons applied.
Plot 6. Formalin (commercial), 2 ozs. to 1 gall. water; 20 gallons applied.
Plot 7. Formalin (commercial), 1 oz. to 1 gall. water; 20 gallons applied.

Plot 8. Petroleum 3 parts, water 10 parts; 40 gallons applied.
Plot 9. Control plot; no treatment.
Plot 10. Sulphur ("flowers of sulphur"), at rate of 600 lbs. to the acre, worked into the surface soil.
Plot 11. Quicklime, at rate of 4 tons to the acre, worked into the surface soil.

The phenol, corrosive sublimate, copper sulphate, and iron sulphate were dissolved in water; in the last case the water was hot, and contained the sulphuric acid. The formalin and petroleum were mixed with water; though, in the latter case, a complete mixing was impossible. All the above fluids were applied to the respective plots by a watering-can with a fine rose. The sulphur and lime were applied dry, and mixed into the surface soil.

A few days only after the treating of the soil the sea-kale cuttings were planted.

During the summer little difference was noticeable throughout the bed, beyond the fact that owing to the very bad tilth brought about by the application of the petroleum, the growth not only of the crop but also of weeds was greatly checked; in fact, areas here and there in this plot remained bare all through the summer.

On lifting the crop in the autumn a considerable difference was noticeable in the health of the crop in the various plots. Although the disease was not so virulent as it had been in 1906, it was sufficiently so in the control plots, and in some of the other plots, to be the cause of considerable harm. Although the disease was nowhere so severe as to cause the crowns to rot (as happened in 1906), yet it was present on some plots to an extent sufficient to make the crowns much weaker than they would have been otherwise. Also, in several of the plots, the disease occurred plentifully on the roots; here the danger was that "cuttings" from such affected plants would introduce the disease into the soil of other portions of the garden. This was a real danger, since, as mentioned below, the *Rhizoctonia* disease is able to attack a large number of cultivated plants.

The treated plots gave the following results:—

Plot 1 (copper sulphate).
Plot 2 (iron sulphate).
Plot 3 (control).

Disease prevalent on crown and roots; and although in the case of Plot 1 there was, perhaps, a slight improvement, it did not appear that the use of either copper sulphate or iron sulphate applied in this way was of any practical use against the disease.

Plot 4 (corrosive sublimate).

Disease prevalent on the crown, but did not occur as a rule on the roots. While the treatment was productive, apparently, of some good, it was clear that the use of corrosive sublimate did not clear the soil of the disease.

Plot 5 (carbolic acid).

In this plot, not only were all the plants practically free from the disease, but the crop was heavier and better in every way than on the other plots, the crowns being much larger, and the roots stouter, and quite free from the disease. It certainly appeared as though the application of the carbolic acid had stimulated the growth of the plants.

Plot 6 (formalin).
Plot 7 (formalin).
Plot 8 (petroleum).
Plot 9 (control).

No satisfactory results. There was as much, if not slightly more, disease in the formalin plots as in the control plot, and the plants were poor. In the petroleum plot the disease was as prevalent and as severe as anywhere; also it appeared that the application of the petroleum had affected adversely the growth of the plants. Their growth was noticeably checked in the spring, and the plants subsequently did not make so good a leaf growth as on the other plots, with the result that, on being dug, the crowns proved to be the poorest, and the roots the thinnest, in the whole of the plots.

Plot 11 (sulphur).

While the growth of the plants was good, the disease was prevalent on the crown and roots. There was as much disease here, in fact, as in Plot 11 (control), and it is doubtful if the treatment did any real good at all.

Plot 11 (control).

Disease prevalent on the crown and roots.

Plot 12 (lime).

For some reason the plants were rather poor, the roots being decidedly weaker than in the other plots. There was, however, an almost complete absence of disease on them. The effect of treating infected soils with various quantities of lime certainly requires to be tested further.

Although the positive results obtained in the above series, as to the possibility of treating *Rhizoctonia*-infected soil with fungicides, must be confirmed by further tests before absolute reliance can be placed upon them, the result obtained by the use of carbolic acid was so striking that we have thought it well to mention the fact now instead of waiting for the results of further experiments with soil fungicides, in the hope that gardeners troubled with this disease on sea-kale, or on other plants, will try the use of this simple and inexpensive remedy. Carbolic acid of 90 per cent. purity can be obtained at 8d. a pound, and an ounce is sufficient to treat about 4 square feet. The apparently stimulated growth of sea-kale in soil treated with carbolic acid is a point of interest.

If sea-kale is attacked by this *Rhizoctonia* disease, there is every reason for the gardener to endeavour to get rid of the pest, not only on account of the damage it will inflict on this crop, but because this fungus is able to attack numerous other cultivated plants. For instance, asparagus beds may replace the sea-kale bed, when the former plants will be liable to be attacked by the *sclerotia* remaining in the soil. In Belgium serious injury has been reported to asparagus beds from this cause. Among other plants liable to be attacked by *Rhizoctonia* are the carrot, parsnip, turnip, salsify, beetroot, fennel, lucerne, clover, saffron, and a number of wild plants. In the United States it is reported as being a common cause of the " damping off " of seedling plants (including lettuce, cabbage, radish, bean, cucumber). It has been known to attack rhubarb, affecting the base of the petiole of the leaf ; a stem-rot of carnations has also been attributed to the same cause.

Two cases occurred recently in the vegetable department at the College. In the first case, the roots of several plants of parsley (which had been planted along one side of the affected sea-kale bed) became attacked, and were gradually more or less destroyed.

It does not appear that parsley has hitherto been recorded as a host-plant of *Rhizoctonia.* In the second case, seedling plants of lettuce were attacked, and destroyed in much the same manner as when attacked by the true " damping-off " fungus.

Finally, it must be mentioned that a species of *Rhizoctonia* often attacks the potato, forming small, hard, blackish or brownish *sclerotia* on the surface of the tuber. The *sclerotia* are very firmly adherent to the skin of the tuber ; so that scrubbing with a scrubbing brush often fails to remove them. In the autumn of 1907, this disease was noticed for the first time on the potatoes in the vegetable department at the College. On microscopical examination it does not appear that the *hyphae* of the mycelium break through the skin of the tuber but, together with the *sclerotia* which are formed later, remain entirely superficial. Thus no harm, apparently, is done to the tubers, except that the appearance of the tubers, when the attack is severe, is ruined for show purposes. There is also the danger that by the use of *Rhizoctonia*-infected " seed " potatoes, a gardener may introduce the fungus into healthy soil, where it may extend and attack various crops. In the United States Prof. Clinton, in 1905, described and figured *Corticium vagum* var. *Solani* as the fertile stage of *Rhizoctonia.* Further, a " rosette " disease of the potato " haulm " (which causes an early dying of the " haulm " before the formation of many tubers, and also an excessive branching and " rosette " or cluster arrangement of the branches) has, in the United States, been traced to *Rhizoctonia.*

Experiments planned to ascertain whether *Rhizoctonia* on sea-kale is able to attack potatoes, and also whether potato-tubers affected with *Rhizoctonia* can be " steeped " in a chemical sufficiently strong to kill the *sclerotia* without injuring the tuber, are already in hand.

Infection-Experiments with *Chrysophlyctis endobiotica,* the fungus causing the "warty disease" or "black scab" of potatoes.

By E. S. Salmon and T. E. Crompton.

In the autumn of 1907 some experiments were made, in which the resting sporangia of *Chrysophlyctis endobiotica* (see p. 285) were subjected to artificial freezing, in order to see what effect such treatment would have on their powers of germination.

Healthy tubers of "Ninety-fold" were used as the material for inoculation, this variety being chosen because of its early production of shoots. The sets were started under glass, and potted up in local soil free from any trace of this disease.

The inoculation of the growing sets was made as follows :—The warty outgrowths (or portions of them), full of mature resting-spores,* were taken early in November, from badly diseased potatoes obtained from Nottinghamshire. This material was subjected to artificial freezing at different temperatures, by being placed in a cold chamber surrounded with a mixture of salt and ice. The series of treatments was as follows :—

Series I. 4 hours at a temperature varying from —5° to —8° C.
,, *II.* 3½ ,, ,, ,, —2° to—3.3° C.
,, *III.* 1¾ ,, ,, ,, —5° to —6° C.

After being treated as above, the warts were broken up in distilled water to set free the resting-spores and the water with its contents was poured over the uncovered crown of the sprouting potato, which was then covered lightly over with mould. Two sets were treated thus with material from each of the above series ; and one set with material which had not been frozen.

At the same time a number of resting-spores were taken from the material in each of the series, and set up in hanging drops in Ward tubes. Under these conditions, however, we failed to induce any germination,* either in this series or in the numerous other attempts, made during the winter and spring, with different nutritive media, and with various preparatory treatment of the spores.

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* See p. 288.

The potatoes, though kept in a greenhouse under conditions somewhat disadvantageous to vigorous growth, grew out slowly through the winter. On February 26th the first thorough examination of the inoculated plants was made. It was found that one of the plants inoculated with material from Series III. had become infected. In this pot there appeared just above the ground a small, green, warty or crested growth, which proved, on examination, to be a young shoot that had been attacked in a very early stage by the fungus, and transformed into a warty or coral-like mass. The "seed" tuber was taken up and photographed; a reproduction of this is given in Plate . On the left the base of a normal healthy shoot is seen; on the right is the diseased shoot transformed and permanently arrested in growth, in consequence of having been attacked by the resting-spores. On microscopical examination it was found that the fungus had already formed new resting-spores in the interior of the excrescences of the attacked shoot. None of the other plants at this time showed signs of having been attacked, and so were left undisturbed.

The final examination was made on June 22nd, when all the plants had ceased growth and ripened off. At this date one of the plants treated with material from Series I. was seen to be infected. In this pot the total yield consisted of a single very badly attacked tuber, which was much deformed by the formation of several of the warts or excrescences which are so characteristic of this disease (see Plate XXVI.). The remaining plants, including the one inoculated with untreated material, showed no signs of having been attacked.

The result of one experiment shows, then, that if resting-spores are subjected, in November, to a temperature varying from—5° to—6° C. for $1\frac{3}{4}$ hours, they are able, if provided with sprouting potatoes, to germinate and infect them at once. In the normal course of the life-history of this fungus, it is believed that the resting-spores lie dormant for many months through the winter until they attack the potatoes in the following season. It would appear that, as a result of the exposure to cold which was given in the above experiment, the resting-spores were enabled to dispense with the usual dormant period. The second experiment in which infection was obtained demonstrates that an exposure for four hours to a temperature varying from—5° to—8° C. does not destroy the germinating powers of the resting-spores. Any system, therefore, of the winter ploughing of soil infested with the disease, with the object of destroying the spores by exposure to frost, would seem likely to be useless.

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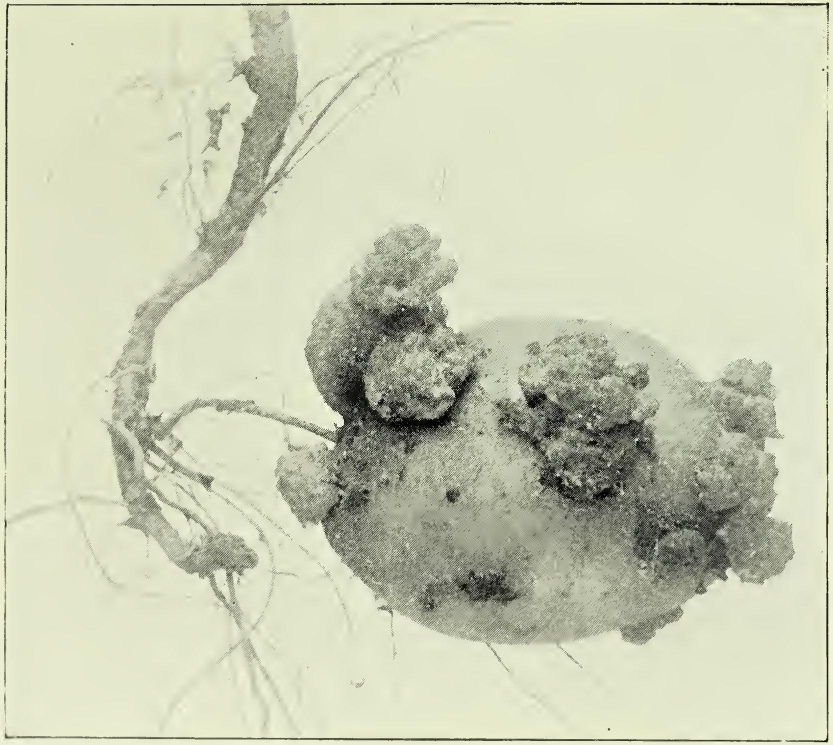
* Prof. M. C. Potter has recorded a similar experience (*Journ. Board Agric.* IX., Dec. 1902).

A few further experiments were made. On November 9th, a healthy set of "Ninety-fold" was planted in a pot of soil (obtained from Nottinghamshire) which contained numerous fragments of the warts or excrescences of diseased potatoes. On April 10th the potato plant was seen to have contracted the disease. Numerous warty excrescences had made their appearance round the main stems, just below the soil; these excrescences proved to be lateral shoots, which had been attacked and deformed by the fungus. A small, greenish, diseased tuber appeared close to the surface of the soil.

On the same date (November 9th) a badly infected tuber had been set in a pot of clean (local) soil; this entirely failed to come up. Another tuber, however, which was slightly attacked by the disease in the neighbourhood of the "eyes," planted under similar conditions, grew up and yielded a crop of small, but apparently healthy, tubers.

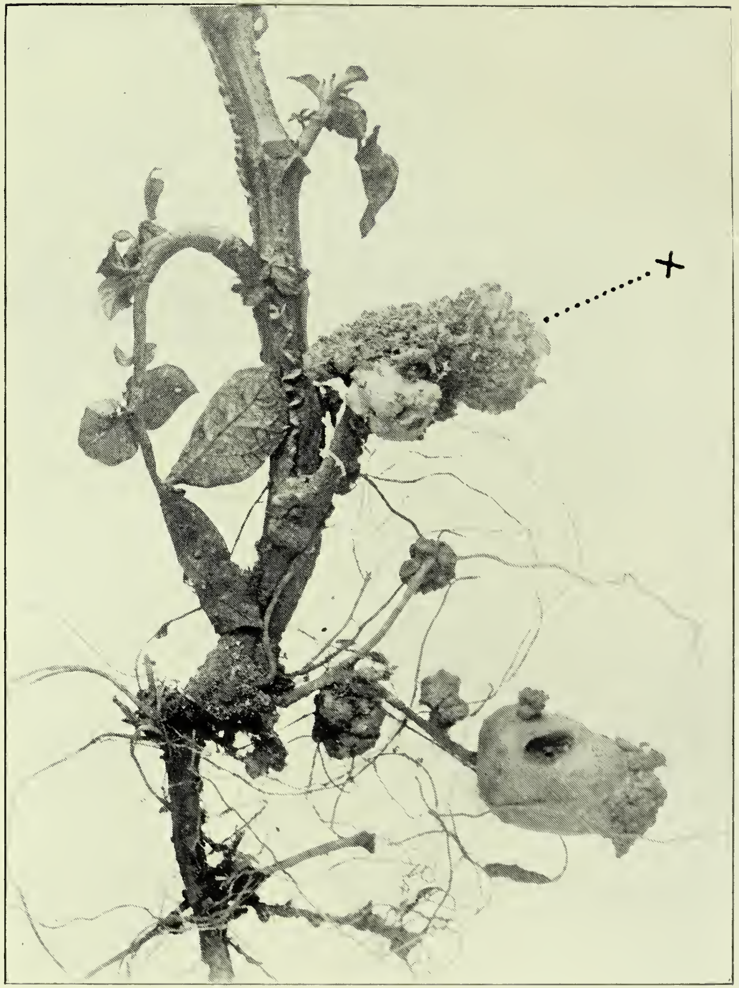
PLATE I.



[*W. H. Hammond, photo.*

Photograph of a diseased potato attached to the stem. The warty excrescences are due to the attacks of the "Black Scab" fungus.

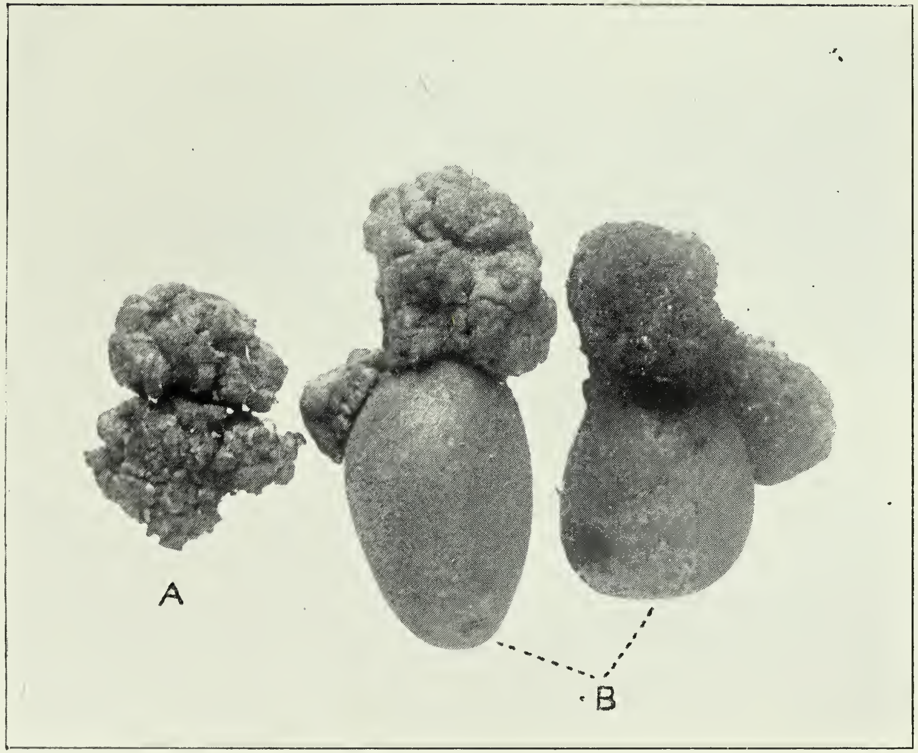
PLATE II.



[*W. H. Hammond, photo.*

Photograph of a growing potato plant attacked by the "Black Scab." At **X** is a diseased shoot above ground; several young diseased potatoes can be seen below.

PLATE III.

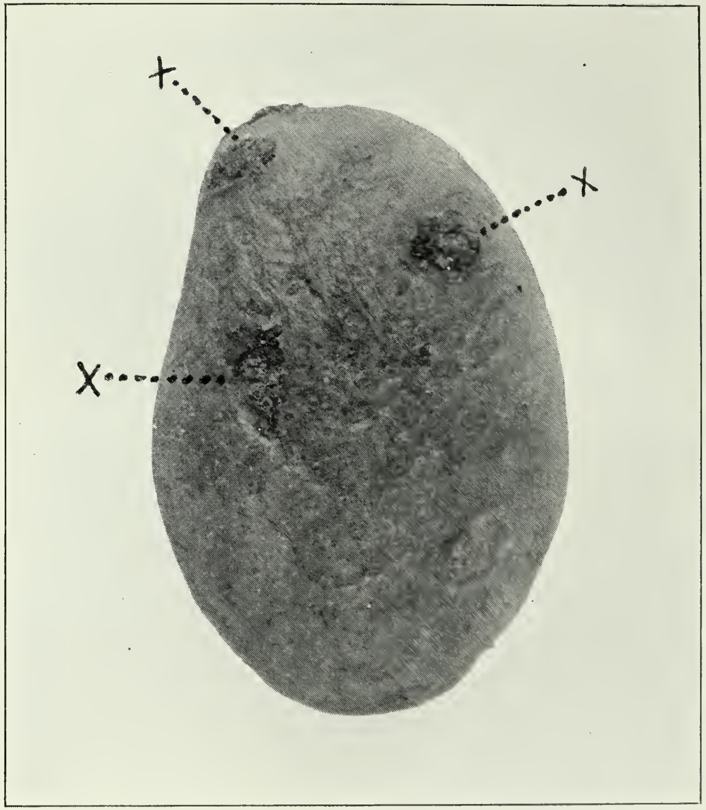


[*W. H. Hammond, photo.*

PHOTOGRAPH OF POTATOES AFFECTED WITH "BLACK SCAB."

In A the potato has been attacked when quite young; in B the older potatoes have been attacked at the end and side.

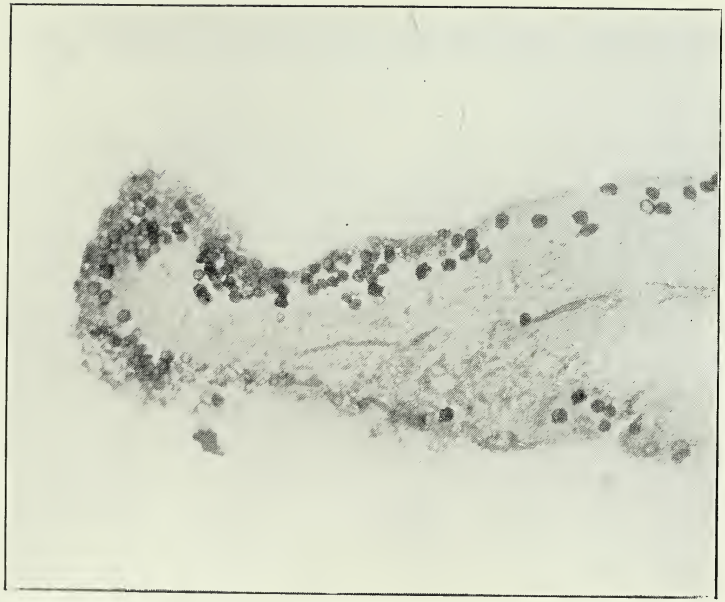
PLATE IV.



[*W. H. Hammond, photo.*

Photograph of a slightly diseased potato. At **X** are small excrescences which are full of the spores of the fungus.

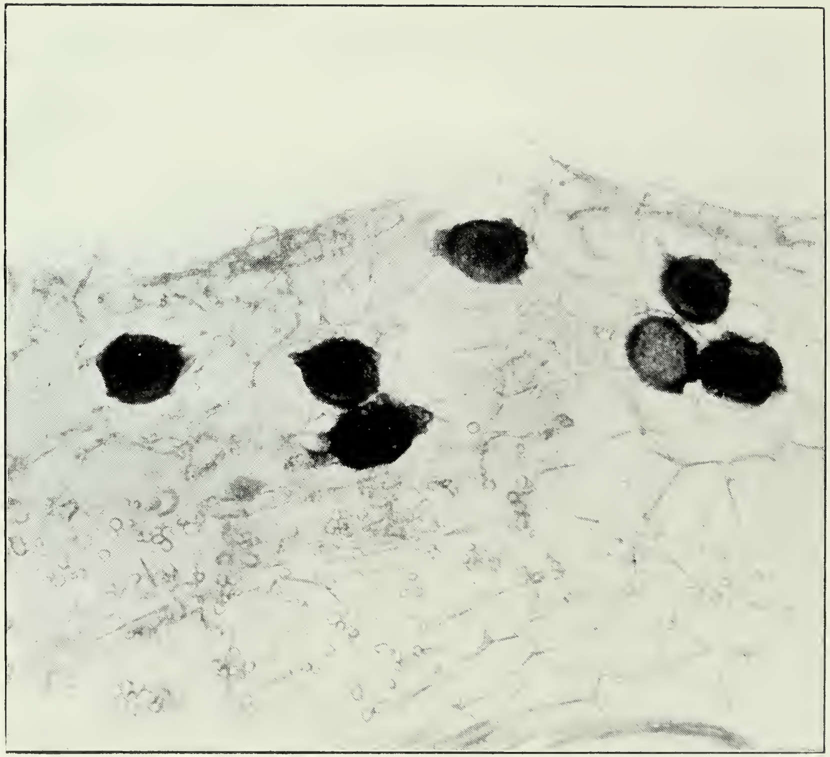
PLATE V.



W. H. Hammond, photo.

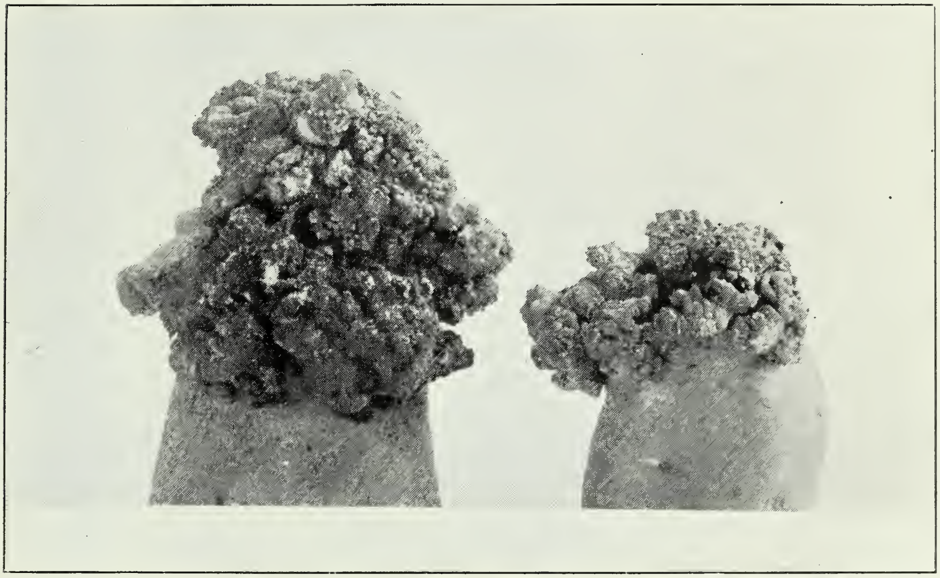
Microphotograph of a section of part of one of the excrescences formed on the diseased potato shown in Plate I. Numerous spores of the fungus can be seen lying just below the surface. Slightly magnified.

PLATE VI.



[*W. H. Hammond, photo.*

Microphotograph of part of the same section shown in Plate V. Seven spores can be seen lying in the flesh of the potato just below the surface ; the starch grains are visible below. Highly magnified.

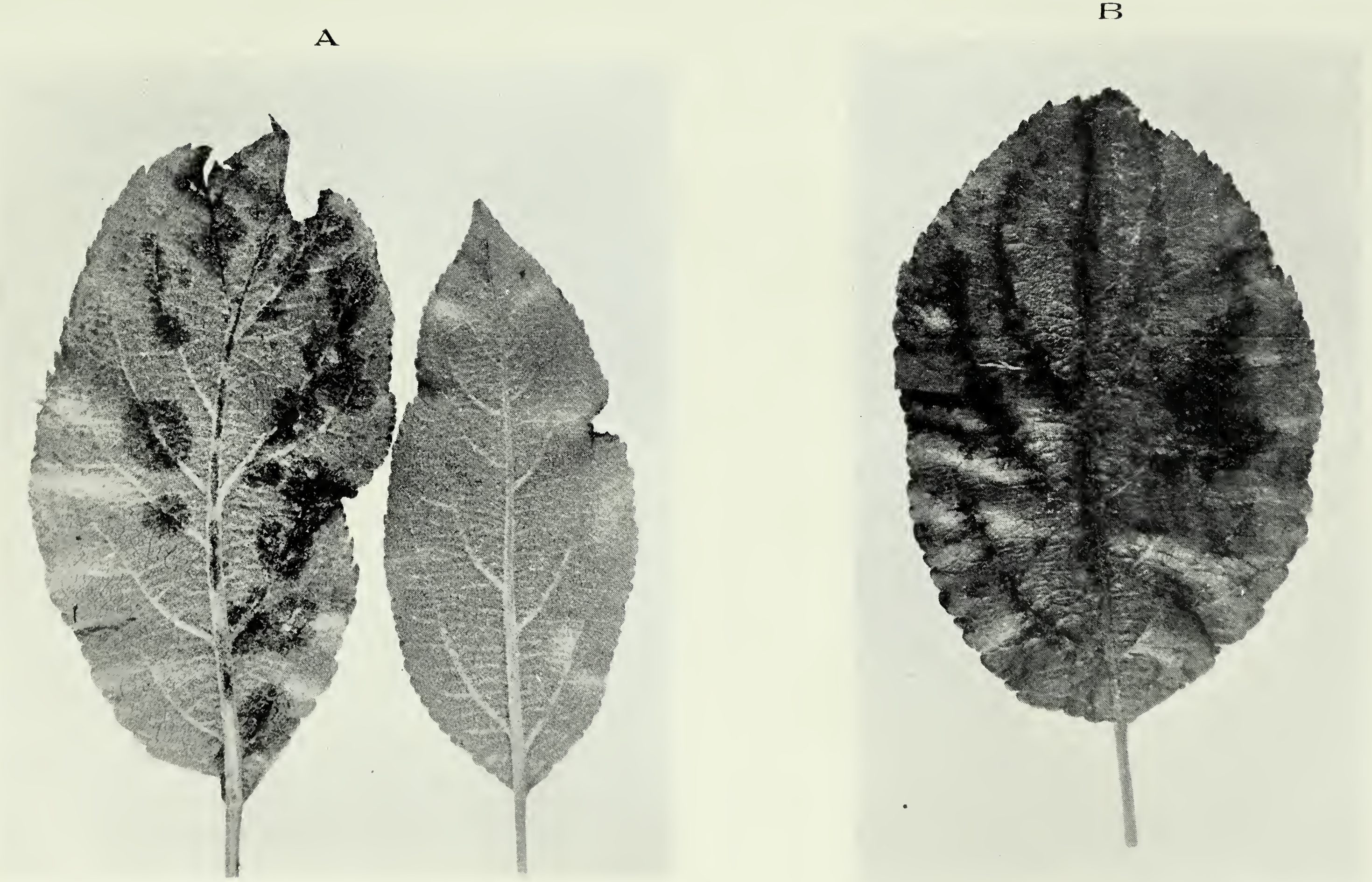


[*W. H. Hammond, photo.*

PLATE VII.

Photograph of the ends of two potatoes, badly affected with the disease.

Plate VIII.



[*W. H. Hammond, photo.*

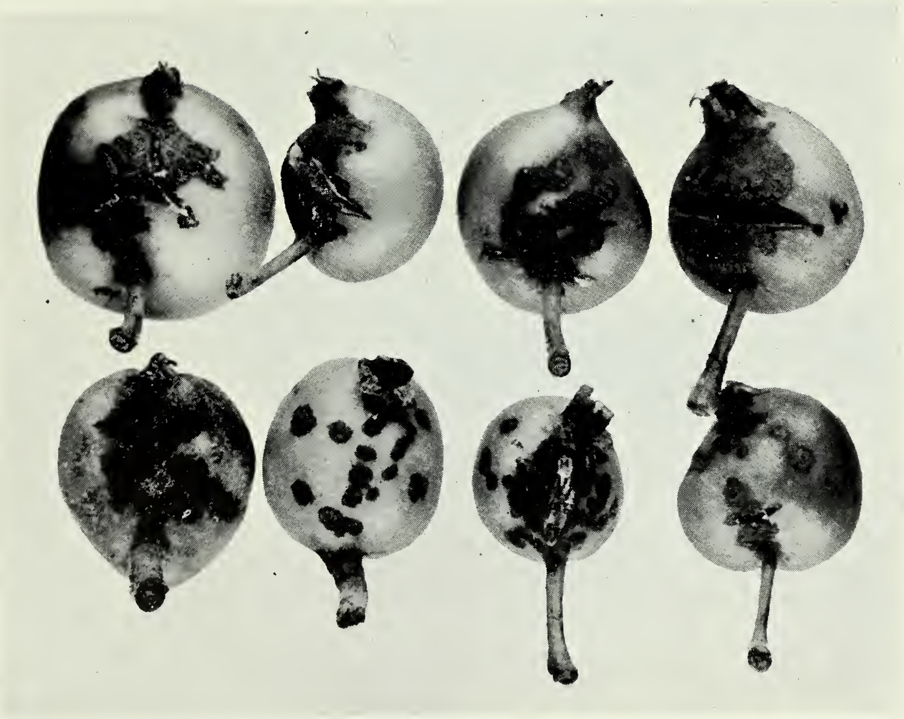
[*W. H. Hammond, photo.*

The Apple Scab or " Black Spot " Fungus attacking the Leaf.

In A (under-surface of the leaves of " Bismarck ") the fungus forms distinct blotches scattered over the surface and mid-rib. A healthy leaf is shown to the right.

In B the fungus follows more or less the course of the veins on the upper surface of the leaf.

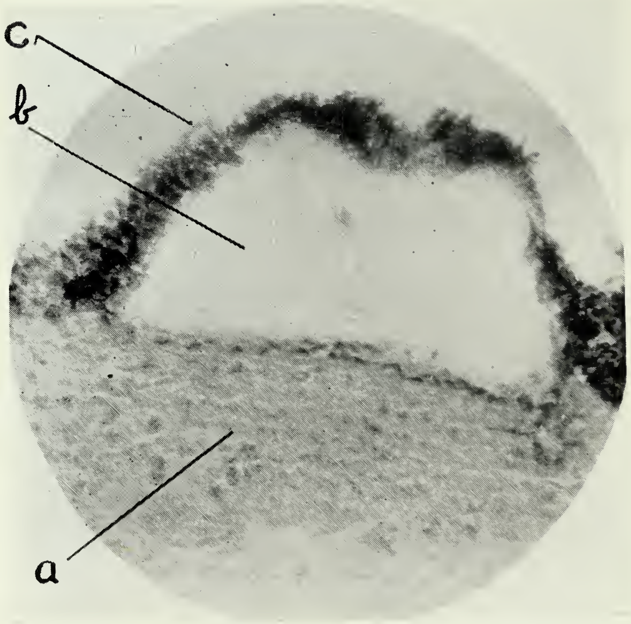
PLATE IX



[W. H. Hammond, *photo.*

Young apples attacked by the Apple Scab or " Black Spot " fungus; showing the cracking seen in severe attacks of this disease.

PLATE X.

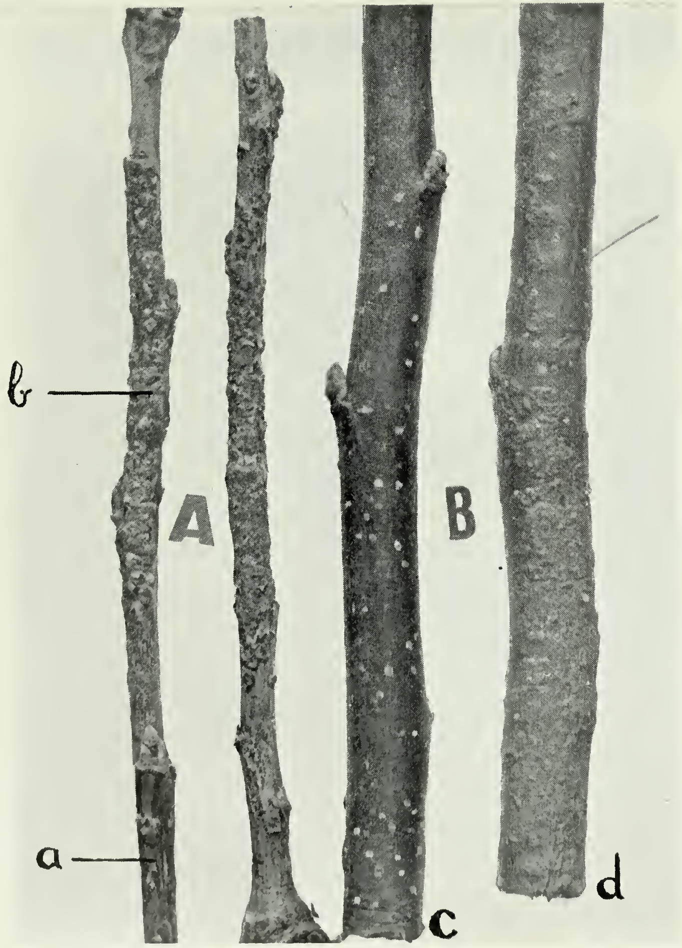


[W. H. Hammond, *photo.*

Microphotograph of a section of one of the pustules of spores from the diseased twig of Cox's Orange Pippin shown in Plate XI.; *a*, cells of the twig; *b*, cushion-like mass of fungus-tissue, which has pushed its way out through the bark, and produced over its free surface myriads of spores (*c*). Highly magnified.

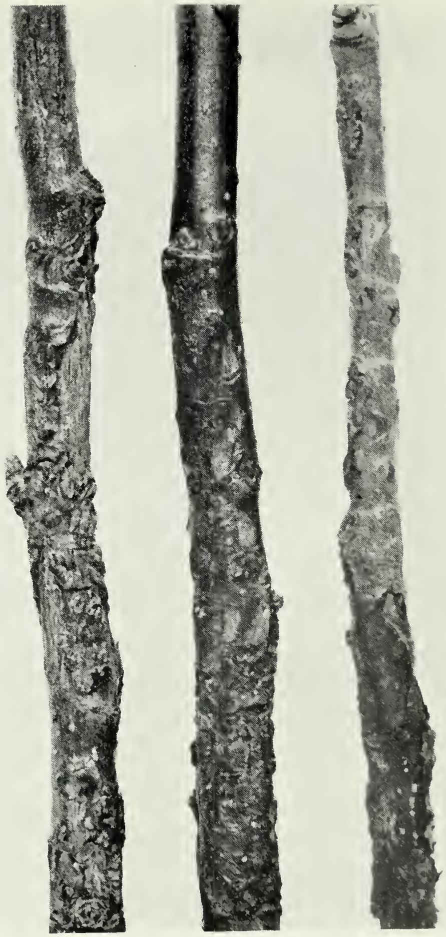
PLATE XI

Fig. 1.



[W. H. Hammond, *photo.*

Fig 2.

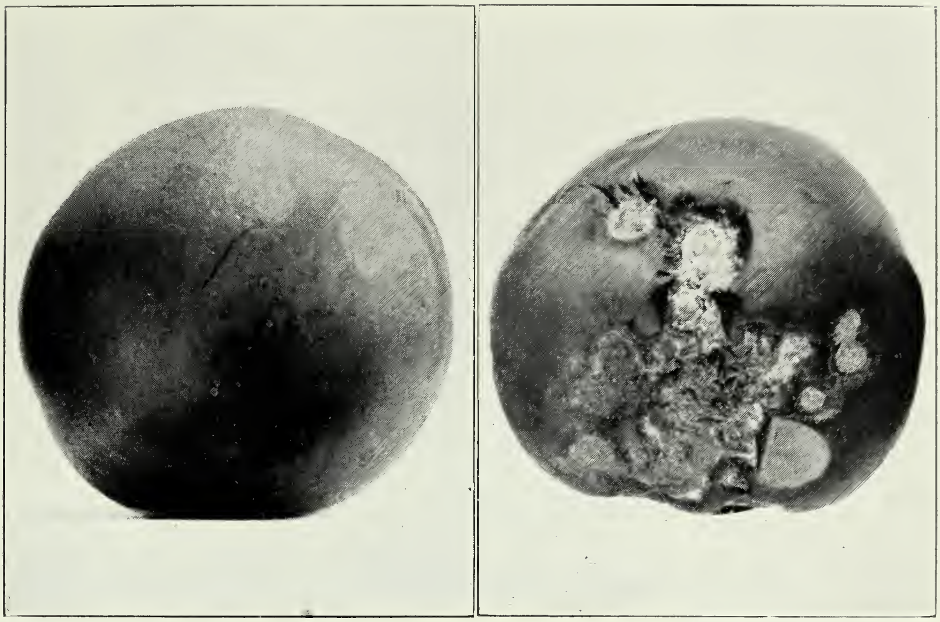


[W. H. Hammond, *photo.*

The Apple Scab or "Black Spot" Fungus attacking the Young Wood of Apples.

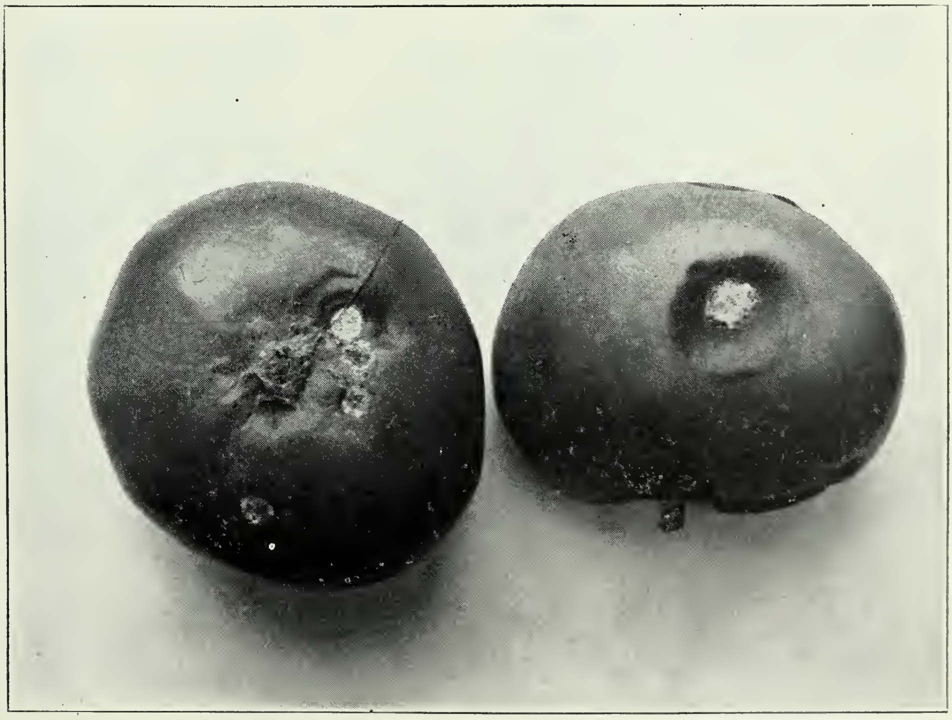
Fig. 1—A. On Cox's Orange Pippin ; *a*, healthy wood ; *b*, diseased wood, the blistered appearance being due to pustules of spores breaking through the bark. B. On Wellington : *c*, healthy wood ; *d*, twig with diseased patch below.

Fig. 2.—"Scab"-infected twigs of "Lord Suffield" ; in places the bark is beginning to peel off in flakes.



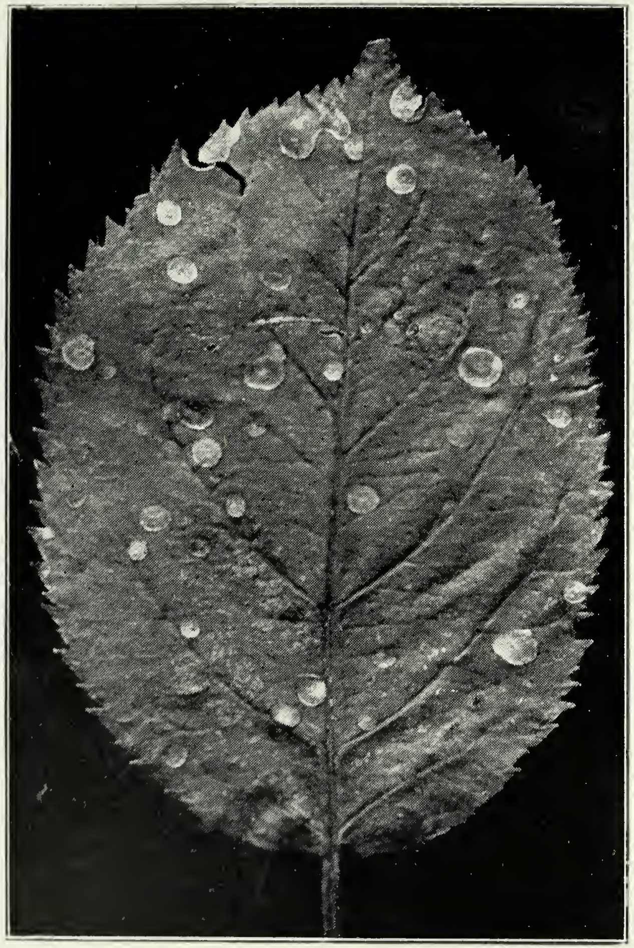
[*W. H. Hammond, photo.*

PLATE XII.
Apple scab prevented by spraying with Bordeaux mixture. To the left is a fair sample from the sprayed trees; to the right, from the unsprayed trees. The variety is "Northern Greening."



[*W. H. Hammond, photo.*

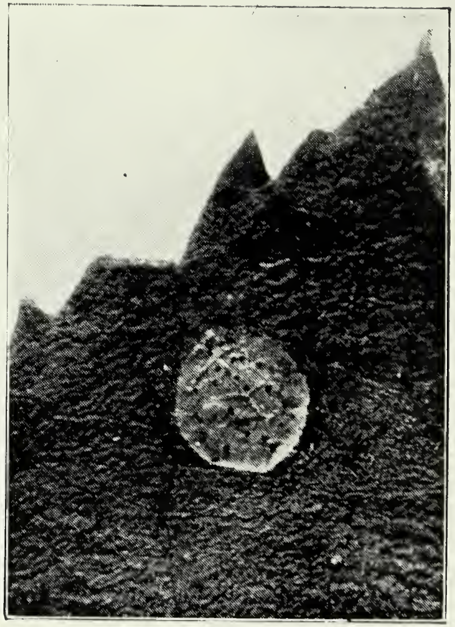
PLATE XIII.
"Rot" of Apples, caused by various "moulds" (appearing as white spots in the photograph), which have gained an entrance through the skin of the apple at the places where apple "scab" or "black spot" has occurred.



[*W. H. Hammond, photo.*

PLATE XIV.

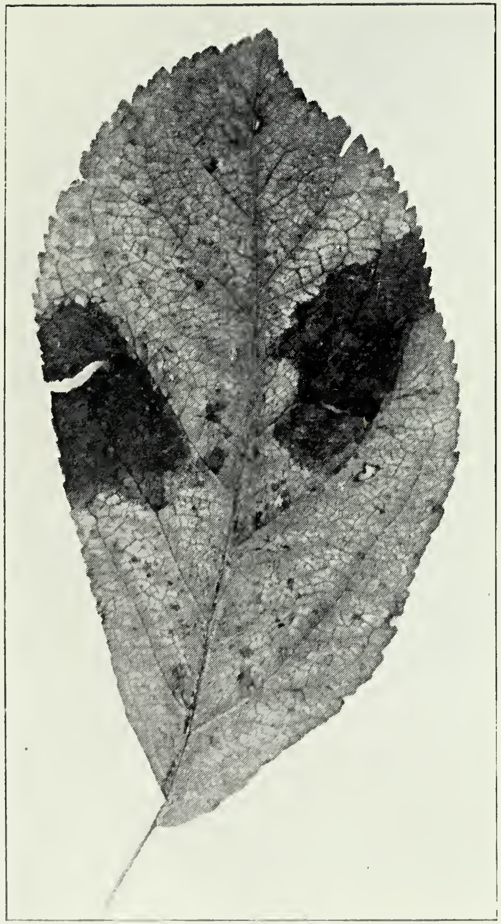
An apple leaf affected with the "Leaf Spot" caused by a species of *Phyllosticta*. One of these spots is shown magnified in Plate XV.



[*W. H. Hammond, photo.*

PLATE XV.

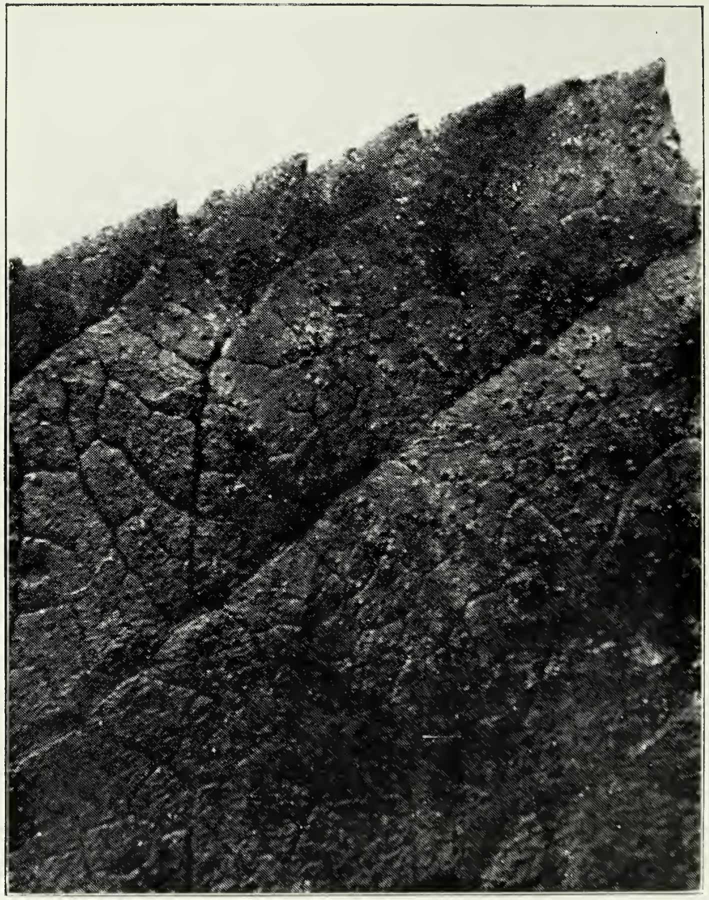
A single "Leaf-Spot," magnified, showing the black dots, which are the fruit-conceptacles (*pycnidia*).



[*W. H. Hammond, photo.*

PLATE XVI.

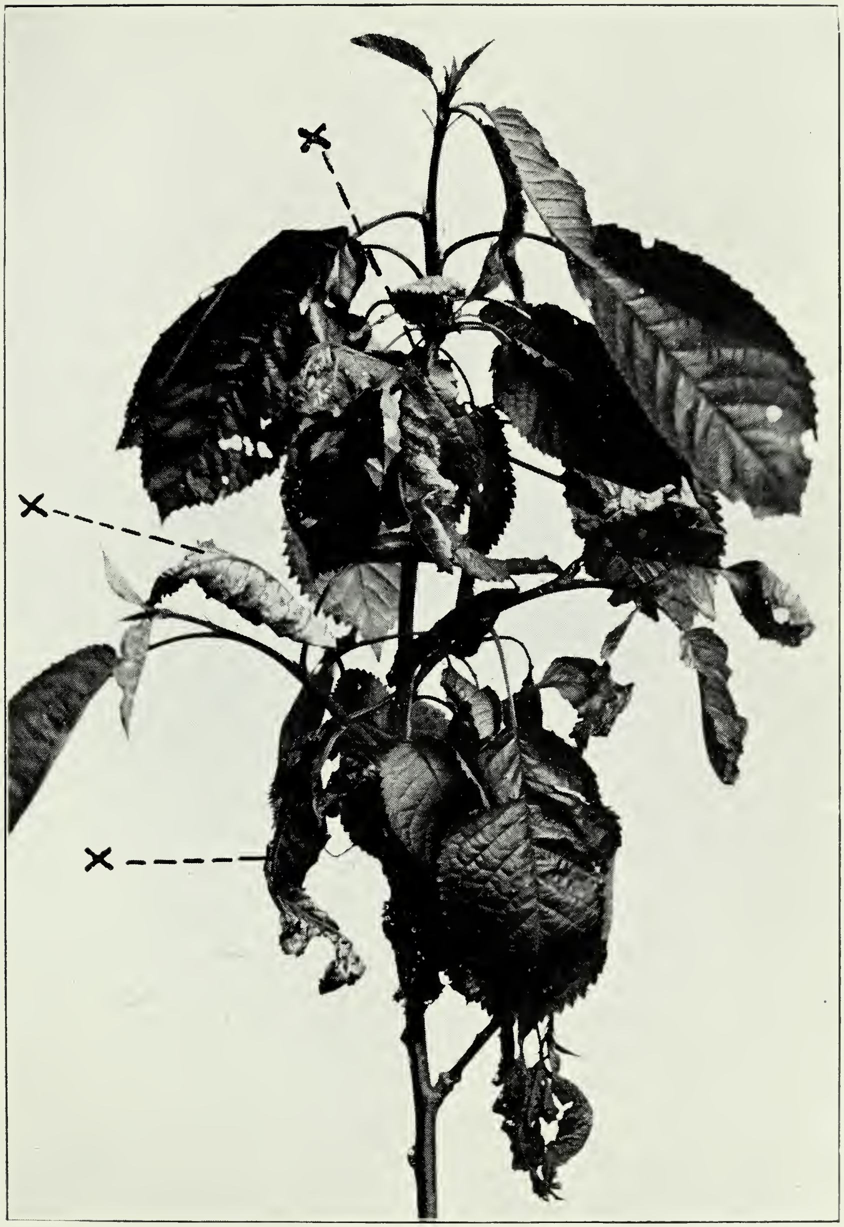
The two brown patches in the apple leaf are caused by a species of *Sphaeropsis*. A portion of one of these patches is shown, magnified, in Plate XVII.



[*W. H. Hammond, photo*.

PLATE XVII.

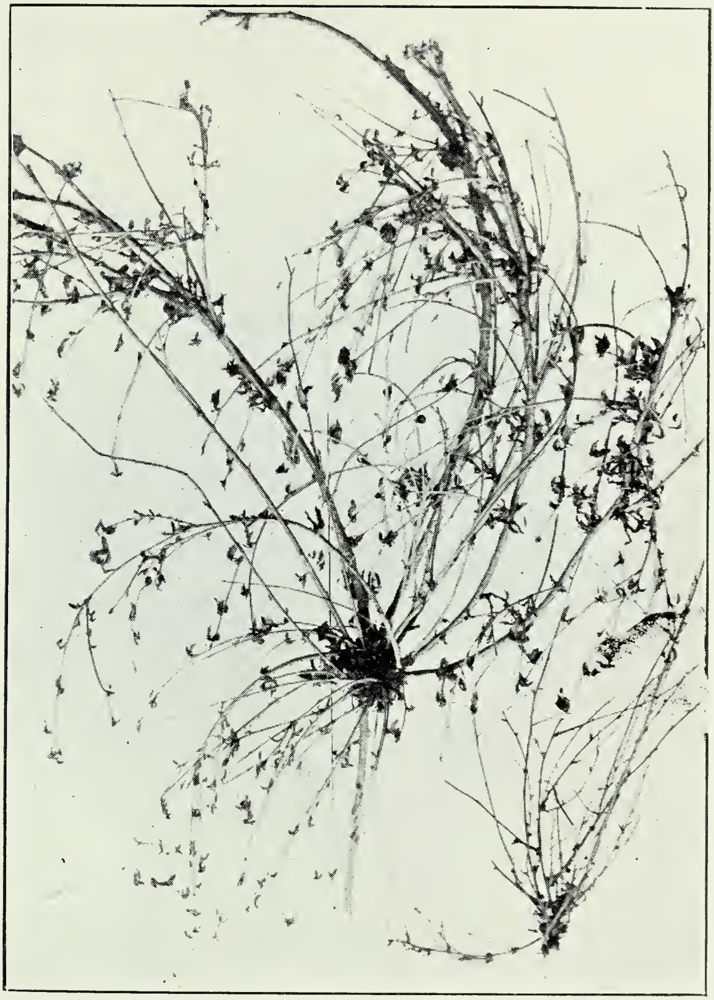
Part of an apple leaf attacked by *Sphaeropsis*. Numerous minute blackish fruit-conceptacles (*pycnidia*) are visible breaking through. Slightly magnified.



[*W. H. Hammond, photo.*

PLATE XVIII.

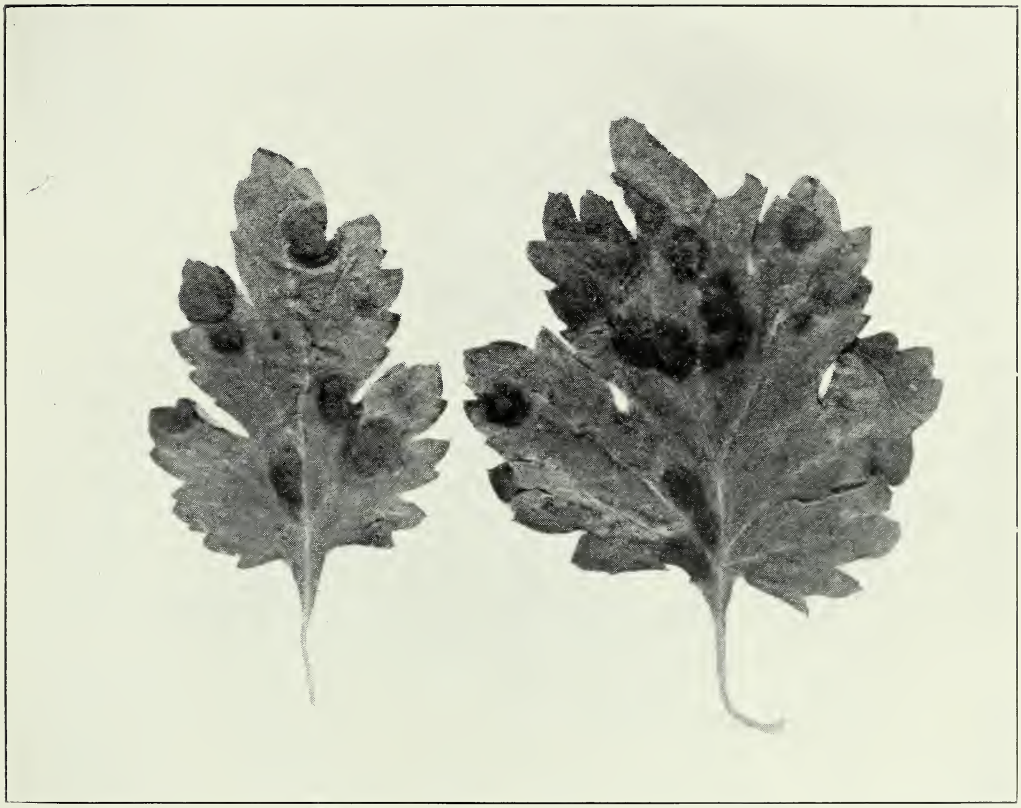
A branch of a Cherry-tree affected with "Leaf-Curl." Three diseased leaves are shown at X.



[*W. H. Hammond, photo.*

PLATE XIX.

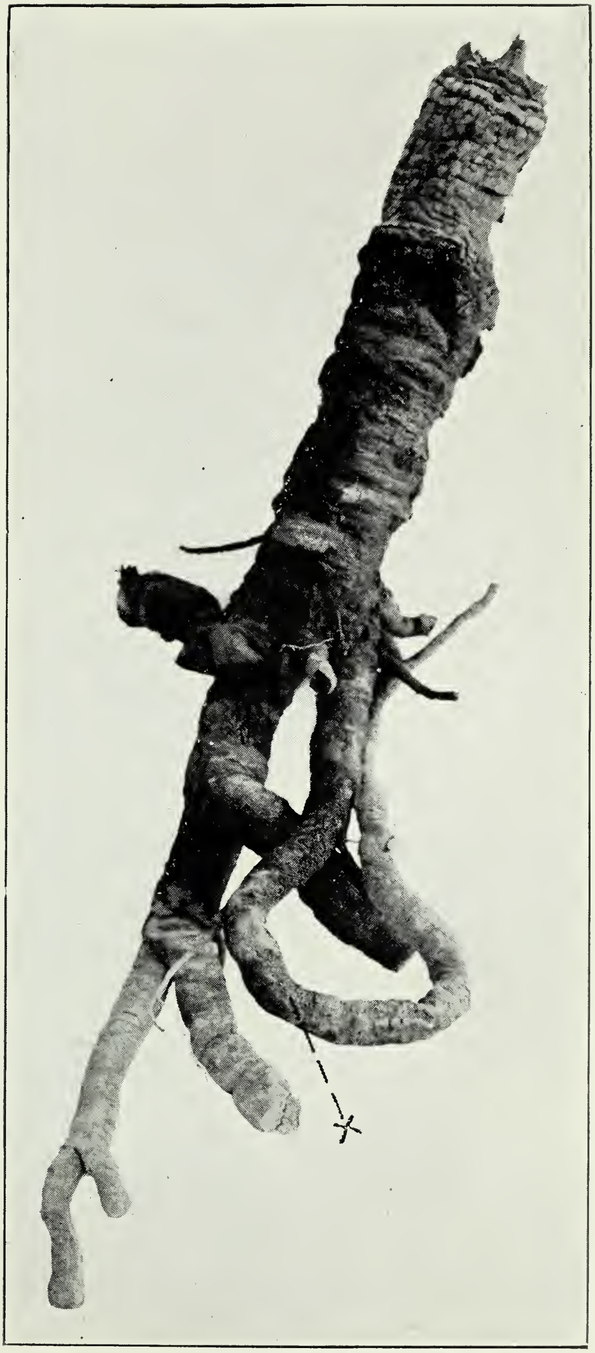
"Witches' Broom" of the Cherry; caused by the fungus *Exoascus Cerasi.*



[W. H. Hammond, Photo.

PLATE XX.

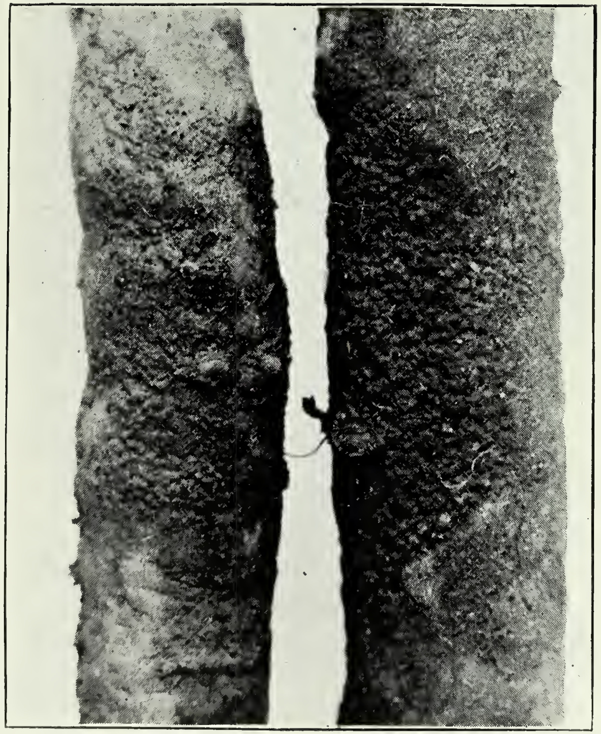
Two Chrysanthemum leaves affected with the "Leaf-Spot" caused by *Septoria chrysanthemella*.



[*W. H. Hammond, photo.*

PLATE XXI.

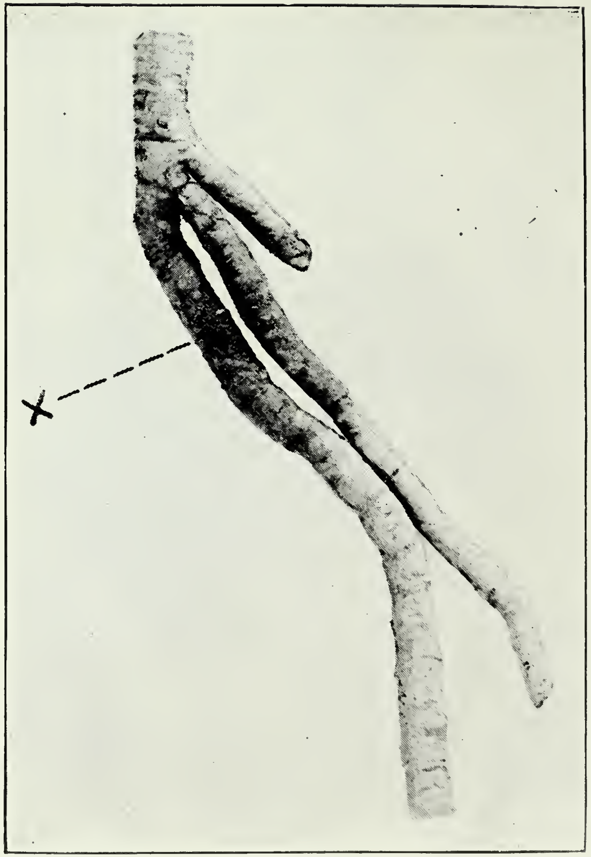
Seakale attacked by *Rhizoctonia*. Parts of the crown and roots are covered with the violet spawn and *sclerotia* of the fungus. The portion at **X** is shown magnified in Plate XXII.



[W. H. Hammond, photo.

PLATE XXII.

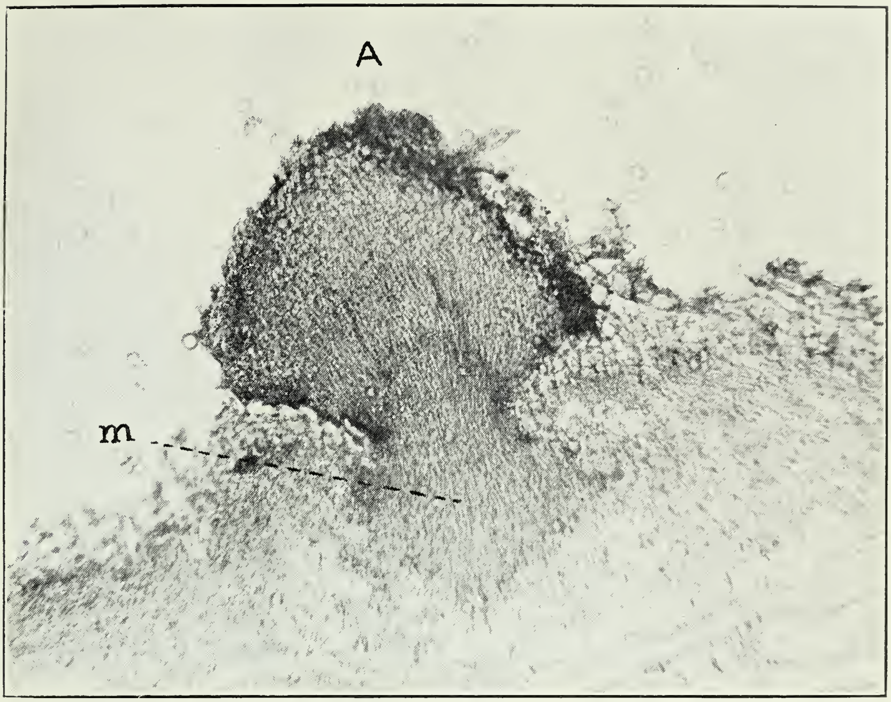
Portions of Sea-kale roots attacked by *Rhizoctonia* ; showing the *sclerotia*. Magnified.



[W. H. Hammond, photo.

PLATE XXIII.

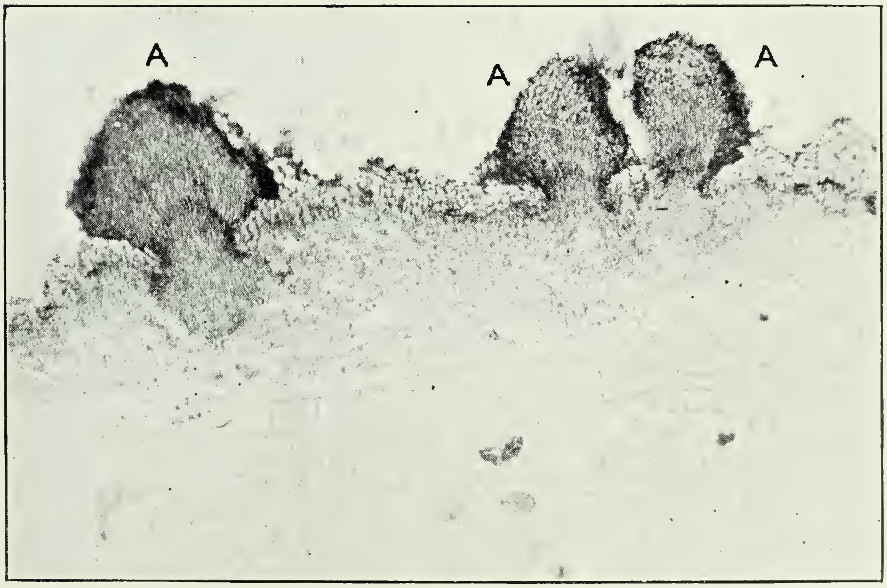
Diseased " cutting " from a Sea-kale plant attacked by *Rhizoctonia*. The violet spawn and *sclerotia* of the fungus are visible at X.



[*W. H. Hammond, photo.*

Plate XXIV.

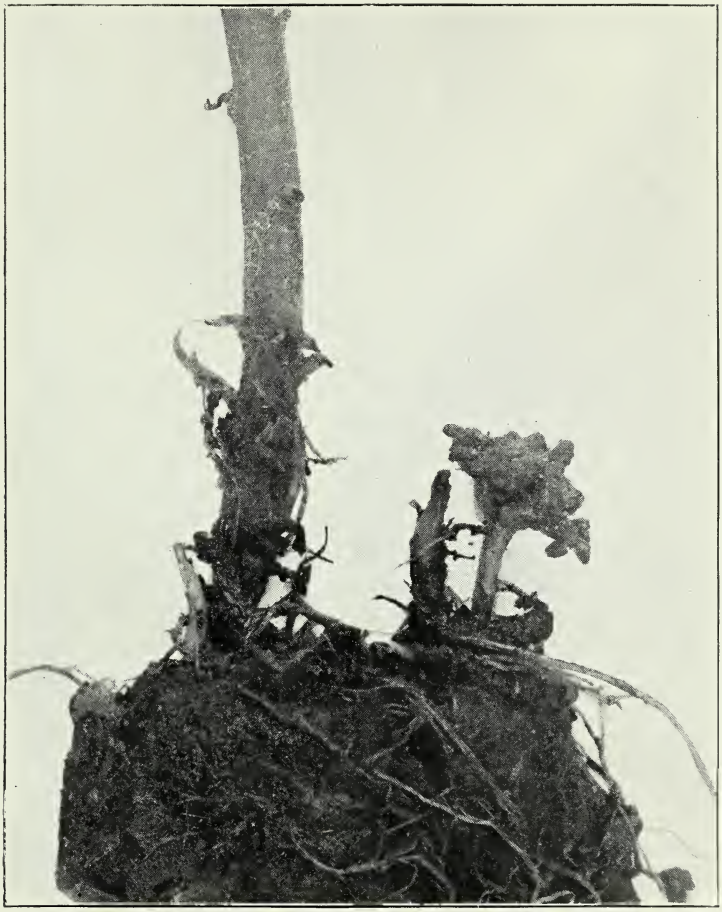
Section of a *sclerotium* of *Rhizoctonia.* At the base mycelial hyphae (*m*) are penetrating into the cortical tissue of the Seakale root (see Plate XXV).



[*W. H. Hammond, photo.*

Plate XXV.

Part of a longitudinal through a Seakale root attacked by *Rhizoctonia.* Three *sclerotia* are seen in section at **A.** One of these is shown more highly magnified in Plate XXIV.



[W. H. Hammond, photo.

Plate XXVI.

A growing tuber of "Ninety-fold," one shoot of which (to right) has been attacked by *Chrysophlyctis endobiotica*. A healthy shoot is seen to the left.

REPORT ON HOPS.

HOP EXPERIMENTS.

By Arthur Amos, B.A.

EXPERIMENTS IN CULTIVATION.

Goudhurst.—Thirteenth Year of Experiments.

The object of this experiment is to test the effect of dispensing with any cultivation beyond that necessary for keeping down weeds.

In 1895, one row in the garden was left uncultivated on either side, except that the soil has been just scratched over to a depth of about an inch to kill weeds; last year this plot was contrasted with two other plots, the one was cultivated deeply in summer and shallowly in spring and summer, whilst the other was cultivated deeply by shims in spring and summer, and not cultivated in winter.

FUGGLES ON SUBSOIL OF WADHURST CLAY.

Plot.	Cultivation.	Crop, 1907.
A	No Cultivation for thirteen years - -	19·1 cwt.
B	Deep Winter Cultivation; Shallow Spring and Summer Cultivation - - -	16·9 cwt.
C	Shallow Winter Cultivation; Deep Spring and Summer Cultivation - - -	16·9 cwt.

The object of this was to find out whether it was the deep winter or deep spring cultivation which caused the difference.

The results for 1907 show that the uncultivated plot is again well ahead, and the other two plots are equal, thus showing that deep cultivation on this soil whether in winter or in spring and summer, is detrimental to the growth of hops.

EXPERIMENT WITH CARBON BISULPHIDE ON WIREWORM.

Wireworm are a source of considerable trouble to hop growers ; they collect round the hop hills in spring and eat off the tiny hop shoots when these are still succulent below ground.

The usual practice, where these wireworm are troublesome, is to put a piece of wurtzel by the side of each hill either at or soon after cutting, and the wireworm, preferring the wurtzel to the hop shoots, feed on the piece of wurtzel and can be collected and killed.

This is a somewhat expensive operation, and may cost about five shillings per acre annually, and it was thought that an injection of carbon bisulphide might exterminate the wireworm.

Accordingly two rows in the College garden were selected ; the hills in one row were treated by injecting two ounces of carbon bisulphide into each ; the bisulphide was injected into the soil at four points about two feet away from each hill. The hills in the other row were left untreated. This operation was done about the middle of April.

The hills in each row were trapped with wurtzel in the usual way, and after about three weeks on May 8th the wurtzel was pulled out and the wireworm carefully counted.

In eighty hills in the injected row there were 336 wireworm, whilst in eighty hills in the control row there were 362 wireworm ; this result shows that the injection of carbon bisulphide is of very little use for wireworm in hops.

EXPERIMENTS WITH HOP WASHES.

I.—*Soft Soap Alone v. Soft Soap and Quassia.*

It has been stated that from theoretical considerations, a wash made from soft soap alone would be as effectual for killing aphis as a mixture of soft soap and quassia containing the same amount of soap; the argument being that the soft soap will kill all it touches whilst the quassia will not kill aphis that it does not touch.

The majority of practical hop growers, however, find that the mixture of soap and quassia is more effectual.

In order to test this point, the main part of the College garden was washed with a horse machine on July 3rd and 12th, with a wash containing 7 lbs. of soft soap and 7 lbs. of quassia per 100 gallons, and on the same day ten rows were washed with a wash containing 7 lbs. of soft soap only per 100 gallons.

For purposes of getting a numerical test of the comparative efficiency of each wash 100 leaves were picked from different bines in each part on July 6th, 15th and 20th, and the number of live lice were counted very carefully on each leaf.

Leaves of approximately equal size were taken by counting down the pair of leaves from the tip of each bine, and taking one of the fifth pair of leaves for the purpose.

Date.	Soap and Quassia. No. of lice on 100 leaves.	Soap alone. No. of lice on 100 leaves.	Ratio.
July 6th	570	1,053	1 : 1.8
July 15th	412	1,756	1 : 4.2
July 20th	1,023	7,641	1 : 7.5

The above table shows the relative killing properties of the two washes; on July 6th, three days after the first washing, there were on the average 5.7 lice on each leaf washed with soap and quassia and 10.5 lice on each leaf washed with soap alone; or for every louse on the leaves washed with soap and quassia there were two lice (approximately) on the leaves washed with soap alone; on July 15th, three days after the second washing, that ratio of lice on the leaves washed with soap and quassia and soap alone is still greater, one to four, and on July 20th, when the leaves washed with soap alone were badly in need of washing the ratio was still greater, 1 to 7.5

The results show that soap and quassia is much more effectual than soap alone as a wash for hop aphis; it seems that the two ingredients act together, and that the quassia is able to kill some of the aphis that the soap alone has failed to do, or else that the quassia makes the leaves unfavourable to the multiplication of the lice.

II. *Paraffin Soap Wash.*

Paraffin emulsion has long been known and used as an aphicide, but it has never been generally used as an hop wash, because of the danger of scorching the hop leaves, owing to the separation of the free paraffin from the liquid; however, it has recently been found possible to obtain an intimate mixture of soap and paraffin, whilst still in a semi-solid condition.

This mixture readily dissolves in hot water, and the paraffin does not separate out on standing as in the case of paraffin emulsion.

It was thought that this mixture would have the combined efficacy of soft soap and paraffin emulsion as an aphicide.

Through the kindness of the Karsam Soap Company, who presented us with a keg of their "Petrocene" soap, we were enabled to test its value.

Two rows in the College garden were washed with the mixture on July 27th and 30th, and August 5th, at the same time as the rest of the garden was washed with soft soap and quassia.

The strength of the Petrocene was 10 lbs. per 100 gallons, and of the soap and quassia 8 lbs. of each per 100 gallons.

After the second washing there were considerably more lice on the leaves sprayed with the paraffin soap wash than on those sprayed with soap and quassia; and on August 8th, after the third washing, the leaves washed with soap and quassia were quite clean, whilst those washed with the paraffin soap wash were so full of lice that they had to be washed again at once by hand.

It is thus clear that the paraffin soap wash is very inferior to the soap and quassia as an aphicide.

One might suppose that as soap and quassia is a better aphicide than soap alone, so soap and paraffin would, in like manner, combine the killing properties of both, but this is not the case.

The value of a solution of soap as an aphicide is due to the fact that the solution is capable of forming a lather, and when hop leaves and aphis are washed with this, it wets them and forms a thin film over their surfaces, and so covers up the breathing pores of the lice, which are in consequence suffocated.

The presence of the paraffin in this wash prevents the soap solution from forming a lather, and, consequently, in this case, the soap does not help to kill the aphis ; the only killing agent is the paraffin.

ON THE VALUE OF THE MALE HOP.

By E. S. Salmon, F.L.S. and Arthur Amos, B.A.

We will commence by giving here the actual paper on the above subject, as it was presented to growers at the Hop Conference held at the College on November 27th last :—

The facts which we have to lay before you this morning relate to the "growing out" of hops. It has probably been the experience of many growers in this room to have had, in one season or another, gardens in which although the hops have shown plenty of bine and plenty of "burr," the yield has been poor through the hops not having "grown out."

In order to be able to give in the necessary detail the evidence which we have collected during the past two years on this subject, we must consider first the structure of a ripe hop. In describing this it is absolutely necessary to use one or two technical botanical words.

Let us take a ripe hop, such as is shown in Plate I. Each hop is made up of what growers call "petals" or "scales." Now, considered botanically, the "petals" or "scales" of which every hop is composed fall into two classes—certain ones are called *bracts*, and certain ones *bracteoles*. The *bracts* and *bracteoles* can be distinguished by their different shape; the *bracts* (A in Plate I.) are more rounded at the ends, which are suddenly pointed; the *bracteoles* (B) are longer, narrower at the tip, and of a brighter yellow colour than the *bracts* when the hop is ripe. In Plate II. we have in the top row two *bracts*; below are two *bracteoles*, bearing seeds; in the bottom row are two *bracteoles* which do not bear seeds. In Plate III. we have two hops dissected to show the way the *bract* A and *bracteoles* B are attached to the strig. It is the invariable rule that in every hop there are two *bracteoles* present for every *bract*. A hop of thirty "petals," or "bracts," will be composed of ten *bracts* and twenty *bracteoles*.

Now we come to the important point, *viz.*, the essential difference between the *bracts* and *bracteoles*. It is this: the *bract* is always sterile, *i.e.*, it never bears a "seed" at its base, while each *bracteole* is capable of being fertile, *i.e.*, of bearing a "seed" at its base.

Now let us consider for a moment what are the possible reasons why healthy hops with plenty of "burr" may not "grow out" and produce large hops.

TABLE I.

Locality & Remarks.	Length of Hop in inches	Seeded Bracteoles	Seedless Bracteoles
Belgian Hops	¾	0	22
	1	0	30
	1	0	34
	1¼	0	40
	1¼	0	46
	1¼	0	46
	1½	0	52
	1½	0	64
	1½	0	66
	2¼	0	102

In the first place it is obvious that the number of *bracts* and *bracteoles*— that is, of "petals"—must account to a certain extent for the length of any hop. You must have something with which to build up the hop; and it is obvious that if you have not enough material in the shape of *bracts* and *bracteoles* to start with, the hop must be small. If the number of *bracts* and *bracteoles* was the only cause which determined the length of the hop, we should find the hop increasing in length only as the number of "petals" increased. Such cases we do find, as a matter of fact, in seedless hops. Table I. shows the structure of ten Belgian hops. We see here that the length of the hop increases as the number of *bracteoles* * increases.

A certain number of cases in gardens in Kent which we have investigated have shown that the hops in question did not " grow out " simply because the number of " petals " produced was not sufficient to build up a large hop. This was due probably to the hop-plants having become weak through adverse weather conditions or to some fault of cultivation or manuring; all such cases as these are excluded from present consideration.

If the production of a sufficient number of " petals " was the only cause on which the " growing out " of hops depended, then the question would resolve itself into one of the proper cultivation and manuring of the garden in order to induce a sufficiently vigorous growth of the hop-plant. But the facts which we have collected show that there is another reason which very frequently accounts for hops not having " grown out." We have met with cases over and over again, where a sufficient number of " petals " were present for a large hop to have been produced, and yet the hops did not " grow out " properly. We are convinced that in such cases as these the grower has a very easy, immediate and inexpensive remedy which will make the hops " grow out," and increase the crop by several cwt. per acre.

You will remember that it was pointed out that the " petals " are composed of *bracts* and *bracteoles*, and that each *bracteole* is capable of bearing a seed at its base.

Our investigations show that it is only when a certain number of these bracteoles bear seeds that the hops " grow out " properly.

It is, then, most important to know how seeds are produced. *In order for a seed to be produced it is absolutely necessary for the flower which grows at the base of each bracteole to be fertilised by pollen-dust from a male hop.*† When a male hop is in flower, its branches on being shaken throw out on the wind a quantity of whitish dust ; each particle of this dust is a grain of *pollen*. (We are using here the word *pollen* in its true botanical sense ; the same word is often used by hop growers to signify the yellow " lupulin " on the "petals" of a ripe hop—sometimes called the "quality" of a hop—and which, of course, is a perfectly different substance.)

---

* For every two *bracteoles* there will be present one *bract*, and their combined number gives, of course, the number of 'petals' in the hop.

† A male hop is frequently called a "seeder" by growers.

When the pollen-dust from a male hop gets carried by the wind to the "burr," (which is a collection of female flowers), it fertilises the "burr," *with the result that a certain number of the bracteoles of the hop bear seeds.*

We will now make two statements, and then give the evidence on which we base these statements.

If there is no pollen-dust carried by currents of air through the hop-garden at the time when the hops are in "burr," the hops will not "grow out" properly, and they will contain no seed at all. Secondly, the more pollen-dust there is about,—or rather, the more fertilisation there is of the "burr" by the pollen-dust, the more seeds there will be in the hop, and the larger the hop will be.

Now to bring forward the evidence in support of the first statement, *viz.*, that no seeds are produced unless the "burr" is fertilized by pollen-dust, and that seedless hops never "grow out" properly.

In our work on the Raising of New Varieties of Hops, we performed the experiment, over and over again, of shutting up in a paper bag a branch of hops just before the "burr" appeared, and keeping the branch enclosed in the bag until all the "burr" had disappeared. No pollen-dust was thus able to get to the "burr." *In no case did one single seed appear in the hop, and in no case did the hop grow out properly.* Other branches on the same bine, and opposite those which produced these seedless hops, were treated the same except that when the "burr" was fully out, the bag was taken off for a moment, and pollen-dust, taken from a male hop, was brushed on to the "burr" with a paint-brush, the bag being then replaced. *The branches thus treated produced fully-seeded and well grown out hops.*

Plates IV. and V. are photographs, showing the relative size of seedless and seeded hops produced by opposite branches on the same bine under identical conditions, except that in the case of the seeded hops shown in Plate V. the "burr" was supplied with pollen-dust. As we shall show later, the College hop-garden this year (1907) gave conclusive evidence as to the disastrous results which follow when no pollen-dust, or only a very little, reaches a garden.

We will stop now to consider for a moment an interesting point, *viz.*, the *first effects* of fertilisation. If experiments, or careful observations, are made, it can be seen that when pollen-dust is carried to the "burr," *the "brush" falls off and the burr grows out into hop at once.* If no pollen-dust is about, the hops remain in "burr" for some time, on the chance, as it were, of some pollen-dust coming along. The photographs shown in Plates VI. and VII. illustrate this fact. In one of our experiments we took opposite branches on the same bine, and enclosed them in bags a few days before the appearance of the "burr." On July 27th the two branches were in "burr"; the bag was then removed from one branch only, and pollen-dust brushed over its "burr." On August 21st both bags were removed; the branch that had been dusted over with pollen had already grown out into fair-sized hops (see Plate VI.); the branch that had not received pollen was so backward that it still bore some "burr" in places (see Plate VII.).

In every case investigated it was the same: if no pollen-dust reached the "burr," the branch remained in "burr" a much longer time, instead of growing out into hop.

Now the time when hops are in "burr" represents, as every grower knows, a very critical period. "Mould" or "blight" may get into the "burr," and the whole crop be lost. In Plate VIII. we have a photograph of a branch in "burr," which has been badly attacked by "mould."

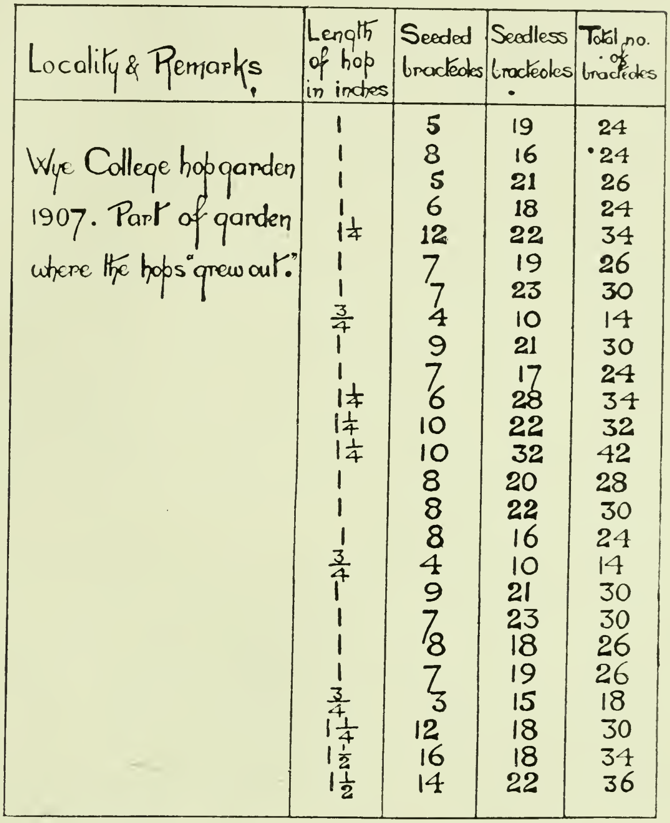
The fact that fertilisation—that is, the action of the pollen-dust on the "burr"—hastens very appreciably the "growing out" of hops, or, in other words, shortens the critical period when hops are in "burr," demonstrates the value of the male hop in one direction.

Now to bring forward the evidence in support of the second statement; that the more seeds there are in a hop, the larger that hop will be,—and consequently the larger the yield per acre.

By general observations in gardens it can be easily seen that well grown out hops contain a good proportion of seed,—at any rate, as regards Golding hops. In the Leaflet published in 1904 by Mr. A. Howard when at Wye College we read the following statement in his investigations on the "growing out" of the hop: "No well grown out hops were seen without seeds." In going over the same ground we have been convinced of the soundness of Mr. Howard's work, and of the great practical importance of his investigations,

Besides making observations in hop-gardens as Mr. Howard did, we have employed a fresh method in order to obtain more detailed and statistical evidence on the question of the influence of the male hop. We have obtained during the past two seasons samples of 25, 50, or 100 ripe hops from hop-gardens scattered over Kent and Surrey. We then made an analysis of *every hop*; *i.e.*, we first measured it, and then picked it to pieces, and recorded in a table the number of *bracteoles* which bore a seed ("seeded bracteoles") and the number of *bracteoles* without a seed ("seedless bracteoles").

TABLE 2.



Locality & Remarks.	Length of hop in inches	Seeded bracteoles	Seedless bracteoles.	Total no. of bracteoles
Wye College hop garden 1907. Part of garden where the hops "grew out."	1	5	19	24
	1	8	16	·24
	1	5	21	26
	1	6	18	24
	1¼	12	22	34
	1	7	19	26
	1	7	23	30
	¾	4	10	14
	1	9	21	30
	1	7	17	24
	1¼	6	28	34
	1¼	10	22	32
	1¼	10	32	42
	1	8	20	28
	1	8	22	30
	1	8	16	24
	¾	4	10	14
	1	9	21	30
	1	7	23	30
	1	8	18	26
	1	7	19	26
	¾	3	15	18
	1¼	12	18	30
	1½	16	18	34
	1½	14	22	36

In Table 2 we have one of these analyses reproduced, taken from the large number of these documents which we now possess.

In the first column the locality of the hop-garden is given; in the second column the length of the hop in inches; in the third, the number of "seeded bracteoles," which is equal of course to the number of seeds in the hop; in the fourth, the number of "seedless bracteoles"; and in the fifth column the total number of bracteoles in the hop.*

In such a table as this we can often see more or less clearly that the number of seeds influences the length of the hop. We see in this table, for instance, that in nearly every case where the hop attains a length of over an inch there is a marked increase in the number of the seeds. But we must remember that we have another cause at work. As we pointed out earlier, the length of a hop will increase according as the number of its bracts and bracteoles increases, even if the latter are all seedless. But even in tables such as is shown in Table 2 we can sometimes find evidence showing that *hops containing the same number of bracteoles increase in length according as the number of seeds increases*. If we look at this table, and running the eye down the last column, pick out only those hops which are composed of thirty bracteoles, we find that it is only when the number of seeds is over ten that the length of the hop reaches to over an inch.

But in such tables as these, we have, as we have said, two different causes (influencing the length of the hop) at work at the same time. To present the evidence in the clearest and most scientific way, *we will compare together only those hops which are composed of the same number of bracteoles*. Then we shall have only one cause at work influencing the length of the hop, *viz.*, the number of seeds. In the series of diagrams shown in Tables 3 to 9, the hops all belong to the Golding type, in which are included the Canterbury White Bines, Brambling, Early Bird, Farnham White Bine, and Mathon. The hops here analysed were obtained from gardens in the following districts: Faversham, Sittingbourne, Maidstone, Ashford, Wye, Petham, Wingham, in Kent; Farnham and Puttenham, in Surrey; and Bodiam in Sussex. The hops were collected by the grower, who was asked to pick one sample from a garden where the hops had "grown out" well, and another from a garden where the hops had not "grown out" well.

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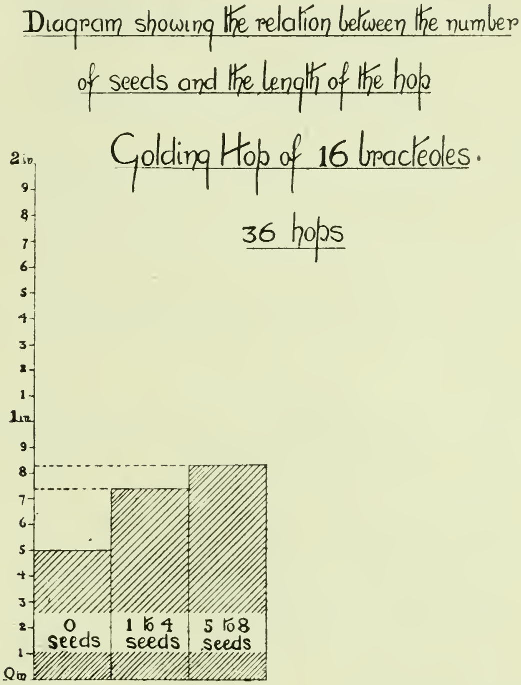
* The *bracts* are not given since they are invariably sterile, and occur always in the proportion of one *bract* to every two *bracteoles*. Thus in the first hop there were twenty-four *bracteoles* and twelve *bracts*, or thirty-six "petals" or "scales" in all.

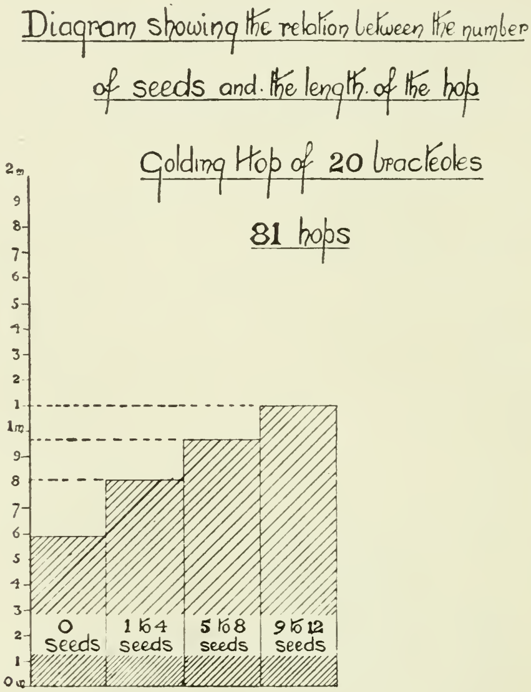
Let us look at Table 3. Each of the three shaded columns represents the average length of Golding hops containing respectively no seeds, one to four seeds, and five to eight seeds, *all these hops being composed of sixteen bracteoles.* The upright scale on the left is divided into tenths of an inch; and by means of it we see that hops containing no seeds attain on the average a length of five-tenths of an inch, *i.e.* half an inch; hops containing five to eight seeds attain on the average a length of between eight-tenths and nine-tenths. In this case, the number of hops (taken from the samples sent in by growers from the districts mentioned above) which were found to be composed of sixteen bracteoles, was thirty-six. We see, then, that in hops having exactly the same structure, *i.e.*, composed of sixteen bracteoles, the average length of the hop containing five to eight seeds is nearly double that of the seedless hop.

TABLE 3.



Take now the case of hops composed of twenty bracteoles, of which eighty-one were found in the samples sent. We see (in Table 4), that the average length of the seedless hops is six-tenths of an inch, and that the length of the hop increases according as the number of seeds increases, the average length of the hops containing one to four seeds being just over eight-tenths of an inch, of those containing five to eight seeds between nine-tenths and an inch, while the average length of hops containing nine to twelve seeds is one inch and one-tenth, or nearly double the length of the seedless hops.

TABLE 4.



In Table 5 we have the results of the analyses of 131 Golding hops, each composed of twenty-four bracteoles. Here again we see that the average length of "seeded" hops containing 13 to 17 seeds is nearly double that of seedless hops.

In Table 6 we have the results of the analyses of 128 Golding hops, each composed of twenty-eight bracteoles, and the evidence is the same.

The analyses of Golding hops composed respectively of thirty-two and thirty-six bracteoles are shown in Tables 7 and 8, and in each case the hops containing a fair proportion of seeds are nearly double the length of the seedless hops.

In Table 9 we have the results of the analyses of fifty-two Golding hops, each of which is composed of from forty-one to fifty

TABLE 5.

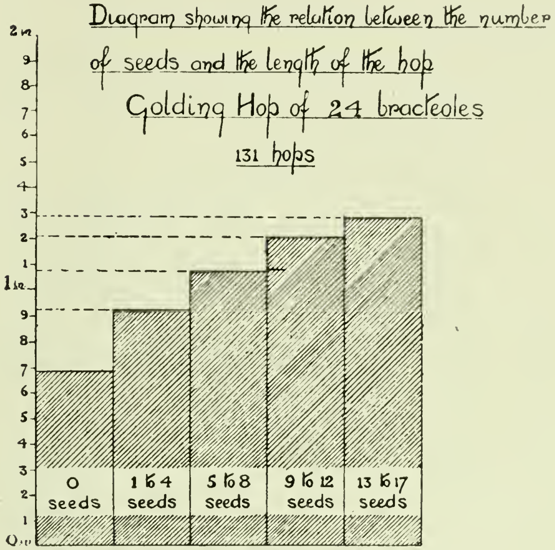
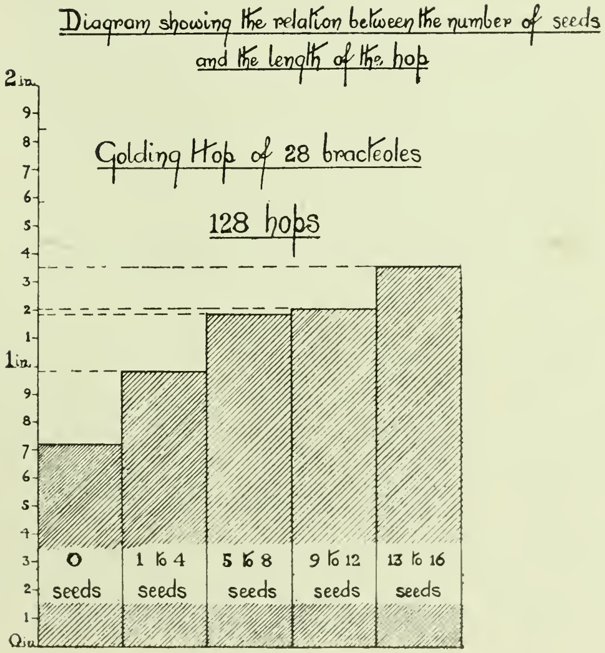


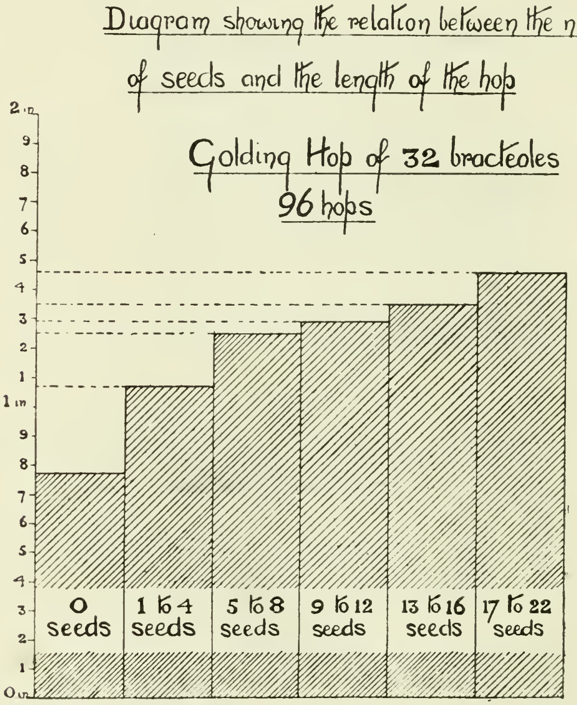
TABLE 6.



bracteoles,—an unusually high number of bracteoles for a Golding hop. Here again we see clearly the favourable influence of the production of seed on the length of the hop. The seedless hop of from forty-one to fifty bracteoles is, on the average, one inch in length; hops with the same number of bracteoles but bearing seventeen to twenty-four seeds have, on the average, an increased length of eight-tenths of an inch.

Let us review the evidence presented diagramatically in Tables 3 to 9. The Golding hops analysed were taken without any

TABLE 7.



selection whatever from samples collected in 1906 and 1907 in gardens scattered over Kent, Surrey, and Sussex. As the most representative series, those hops which were composed of sixteen, twenty, twenty-four, twenty-eight, thirty-two or thirty-six bracteoles were chosen. These were arranged, each in its own class, according to the number of seeds each hop possessed. The average length of the hop in each case was also determined. We find —as can be seen in a glance on looking through the Tables 3 to 9,

TABLE 8.

Diagram showing the relation between the number of seeds and the length of the hop

Golding Hop of 36 bracteoles

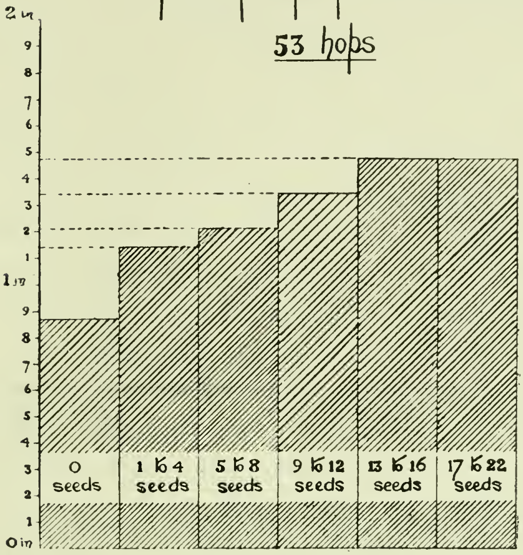
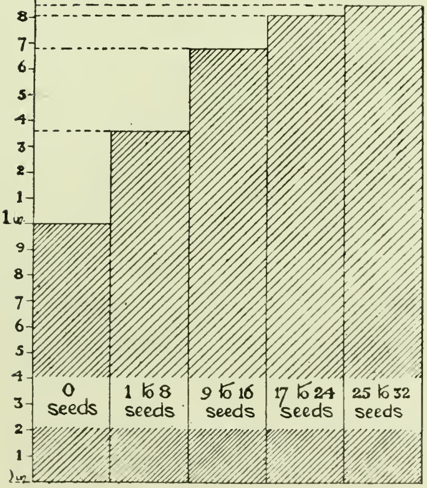


TABLE 9.

Diagram showing the relation between the number of seeds and the length of the hop

Golding Hop of 41 to 50 bracteoles



that in every class,—of hops composed of sixteen, twenty, twenty-four, twenty-eight, thirty-two, or thirty-six bracteoles,—the length of the hop increases regularly and in more or less strict proportion as the number of seeds increases, so that the well-seeded hop is invariably nearly double the length of the seedless hop. In other words, we see that, in hops having the same structure, *i.e.*, the same number of bracteoles, *the length of a hop may be nearly doubled by the production of plenty of seed.*

It must be remembered that a slight increase in the average length of the hop means a considerable increase in the weight of the crop per acre. In a certain case, to be described later, in a Golding hop-garden, an increase of a quarter-of-an-inch in the average length of the hop was found to be equivalent to an increase of four hundredweight per acre in the crop.

The evidence we have obtained from the analysis of nearly 2,000 hops shows conclusively, we consider, *that Golding hops "grow out" properly only when well-seeded, and thus demonstrates clearly the great value of the male hop.*

The good effect of fertilisation, and the consequent production of seed, is seen also in other varieties of hops, *viz.*, in Fuggles and Cobb's Golding, although perhaps it is not so marked as in the case of Goldings. In Table 10 we see that, in the case of Fuggles', a hop which contains on the average twenty-four bracteoles has an average length of one and four-tenths of an inch when the average number of seeds is nineteen, but is only one and two-tenths of an inch long when the number of seeds is nine. We have met with cases, however, as regards Fuggles' hops, where the hops have "grown out" well with only quite a small proportion of seed; and although our investigations into other varieties than Goldings are not yet sufficiently complete to allow us to reach definite conclusions, it appears that Fuggles' hops, in some cases at all events, do not require to the same extent the stimulus which fertilisation gives in order to "grow out" properly, and that they thus differ from Golding hops. This is quite what one would expect, having regard to the greater constitutional vigour of the Fuggles' hop.

We come now to the subject of the difference in the crop caused by fertilisation in certain parts of the College hop-garden in the season of 1907. This is a case where the value of the male hop was shown on a large and practical scale, and the evidence it gives is as valuable as the statistical tables which we have lately examined.

A plan of the College hop-garden (of six acres) is given below. In July there was plenty of bine and plenty of "burr," and the College garden compared favourably with any garden in the neighbourhood. But as the season went on, it became clear that the promise of a good crop was not going to be fulfilled, and as a matter of fact throughout the garden the hops never "grew out," —*except in two places.* In these two places the hops for a certain distance along several consecutive alleys were well grown out and well-seeded, and presented the appearance shown by the upper branch in Plate IX., Plate X., and by the lower row in Plate I. Elsewhere in the garden the hops were miserably small, not grown out and seedless, and presented the appearance shown by the lower branch in Plate IX., Plate XI., and by the upper row in Plate I.

TABLE 10.

Fuggles

Gardens where the average no. of bracteoles in the hop was 23 or 24

Hopgarden	Average no. of Bracteoles	Aver. no. of Seeds	Aver length of Hop in inches
Ashford, Kent	24	19	$1\frac{4}{10}$
Puttenham, Surrey	23	14	$1\frac{3}{10}$
Bodiam, Sussex	23	13	$1\frac{3}{10}$
Farnham, Surrey	24	9	$1\frac{2}{10}$

An investigation of the garden was made in order to discover the cause of the great difference in the hops in different parts of the garden. It was found that there were four male hop-plants in the garden ; their position is indicated by black dots in the plan. The places where the hops grew out well were situated immediately to the N.E. of two of these males,* one male being in the lew row on the S. side, and one being towards the middle of the garden. It seemed therefore probable that pollen-dust had drifted on the wind in a North-Easterly direction from these two males, and had fertilized the "burr" in these two areas, which

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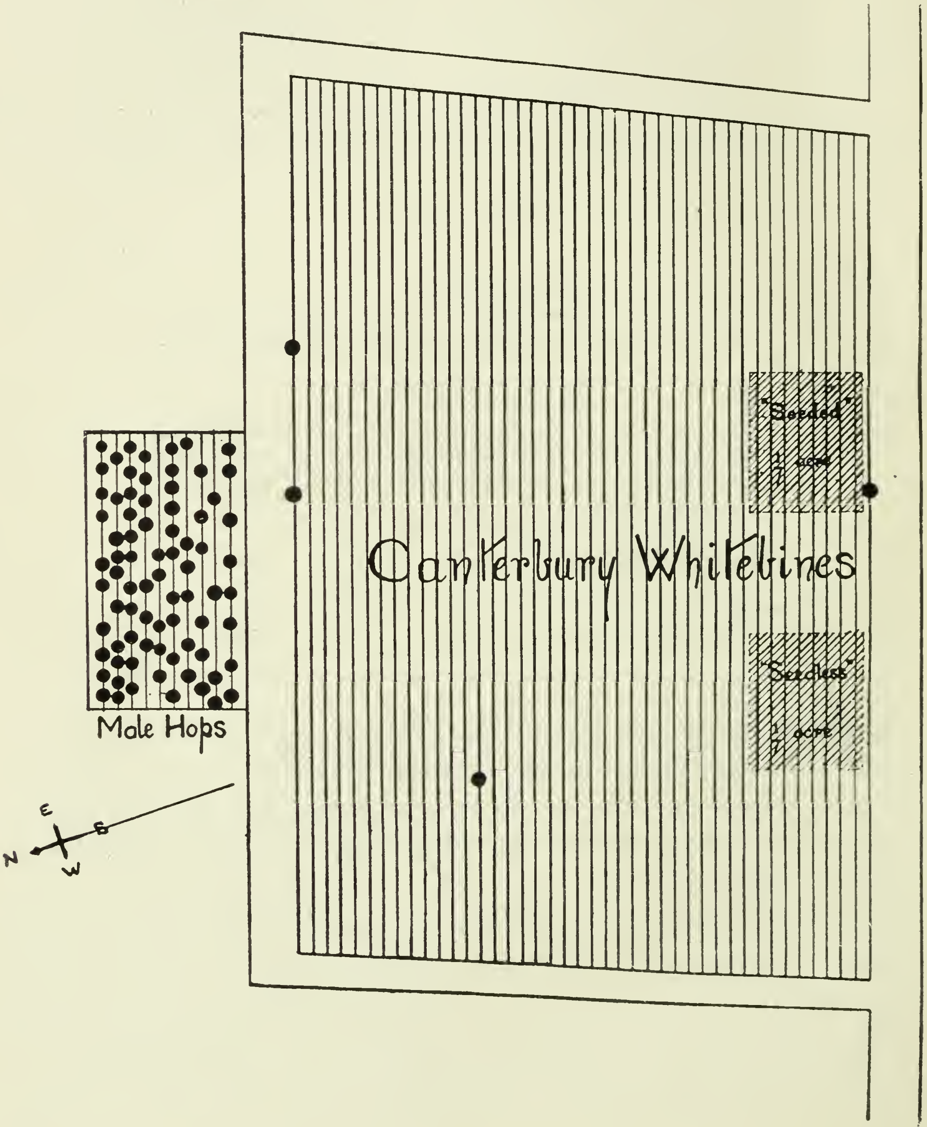
* There were no hops to the N.E. of the two males in the lew row on the N. side.

PLAN OF COLLEGE HOP-GARDEN.



The two areas (of $\frac{1}{7}$ acre each) which were picked separately are shaded; the "seeded" area is above. Each black dot indicates the position of a male hop.

"burr" subsequently developed into well grown out and seeded hops. On consulting the College records of the direction of the wind from July 27th to August 21st, which covers the time when the hops were in "burr," it was found that the wind had been S., or W., or W.S.W. on every day but two, thus confirming the supposition that the pollen-dust had been carried in a N.E. direction to the two places where the hops were well grown out. This meteorological record explains further why pollen-dust was not blown into the garden from the two male plants in the lew row on the N. side, nor from the 77 male plants which are being grown for experimental purposes in a male garden on the N. side (see plan). The College hop-garden occupies an isolated position as regards other hop-gardens; consequently the hops had depended for pollen practically entirely on the male hop in the lew row on the south side and on the male hop towards the middle of the garden.

To ascertain exactly what the differences were in the parts of the garden where fertilisation had occurred, and where it had not, two plots of equal size were selected, and thoroughly investigated. One of the two places where the hops grew out well was situated close to the male in the lew row on the south side; here an area of one-seventh of an acre (comprising parts of eight alleys) was railed off. This area is shown shaded in the plan given above ("seeded"). A few yards to the north-west of this area the hops were miserably small and not grown out. An exactly similar area (comprising parts of the same eight alleys as in the first area) of one-seventh of an acre was railed off here; this is shown shaded in the plan given above ("seedless"). The hops were picked separately from these two areas, and dried, pocketed, and weighed separately. Finally, samples from each pocket were submitted to hop-factors.

The results obtained are given in Table 11. Let us examine them closely. First of all the difference in the general appearance of the hops from the two areas is to be noted. The branch of comparatively well grown out hops shown in Plate X., also the upper branch in Plate IX., and the lower row of hops in Plate I. are representative of the crop obtained in the "seeded" area. The branch of small and not "grown out" hops shown in

Plate XI., also the lower branch in Plate IX., and the upper row of hops in Plate I. are representative of the crop in the "seedless" area.

It is important to note that the hops, characteristic of the "seedless" area, were small, not because an insufficient number of "petals" had been produced, but simply because no fertilisation had taken place through the absence of pollen. This can be seen clearly if we turn to Plate I. The third hop* in the row of "seedless" hops was as a matter of fact composed of more "petals" than the second hop* in the row below of "seeded" hops, and would have attained a greater length than this if it had received pollen when in "burr." As we shall show later, this fact was proved by an experiment carried out in the "seedless" area.

TABLE II.

Wye College Hopgarden Canterbury Whitebines	"Seeded"	"Seedless"
Area picked	$\frac{1}{7}$ acre	$\frac{1}{7}$ acre
Number of Bushels	88½	42½
Dry weight:	1cwt 1qr 9lb	0cwt 2qr 26lb
equal to per acre	8¾cwt	4¾ cwt
Average no. of seeds per hop (100 hops)	9½	½
" length of hop (")	1 in.	¾ in.
" no. of bracteoles per hop (")	26¾	28¼
Value per cwt, as estimated by factors in the Borough, London	84/- to 95/-	54/- to 70/-

Added value due to fertilisation £24·10 per acre;

Now let us study Table II. The number of bushels picked was 88½ from the "seeded" area, 42½ from the "seedless." The dry weight of the hops picked was 1-cwt. 1-qr. 9-lbs. from the "seeded" area, while from the "seedless" area it was 2-qrs. 26-lbs. This is equal to a weight *per acre* of 8¾-cwt. as against 4¾-cwt.

One hundred hops from each area were taken from the green bags at the time of picking, and each hop was picked to pieces, and the results tabulated. It was found that the average number of seeds per hop in the " seeded " area was nine-and-a-half, that is to say, on the average, the first hop would have nine seeds, the second ten, the third nine, and so on. In the " seedless " area the average number of seeds per hop was one-half, that is to say, on the average the first hop would have no seeds, the second one, the third none, and so on.

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* Counting from left to right.

The average length of the hop was one inch in the " seeded " area ; ¾-inch in the " seedless." Now the increase in weight of the crop in the seeded area over that of the " seedless " area was 4 cwt. per acre. This increase was due to the better development of the " seeded " hops as a result of fertilisation and the consequent production of seed. The figures show that an average increase in length of ¼-inch per hop added 4-cwt. per acre to the yield.

We now come to a very important point, *viz.*, the average number of " petals " of which the hops are composed in the two cases. If on analysing the hops from the " seeded " and " seedless " areas it had been found that on the average the hop from the former area contained more " petals," that is, bracteoles and bracts, than the hop from the latter, the increase in weight per acre on the " seeded " area might have been due to the increased vigour of the bines in that part of the garden. But the analysis showed that, judging from the number of bracteoles per hop, the bines in the " seedless " area were quite as vigorous as those in the " seeded " area, since in the " seeded " area the average number of bracteoles per hop was only 26¾, while in the " seedless " area it was 28¼. *It is quite clear, therefore, that the increase in yield shown by the bines in the " seeded " area was due solely to the fact that the " burr " had received pollen-dust from a male hop.*

Dried samples were then submitted to several well-known firms of hop-factors in the Borough, London. The prices quoted by them were as follows : for the " seeded " hops, 84s. to 95s. ; for the " seedless," 54s. to 70s. Taking these figures and those of the yield of the two areas, we find that the difference in the value of a crop of 8¾-cwt. at the average between 84s. and 95s., and one of 4¾-cwt. at the average between 54s. and 70s., is equal to the sum of £24 10s. per acre.

To sum up : the male plant in the lew row on the south side of the garden (see plan, above) had, through fertilising the "burr" with its pollen-dust and so making the hops "grow out" better, increased the crop at the rate of 4 cwt. per acre, or in other words, this male plant had increased the value of the crop (at the price of hops then current) by the sum of £24 10s. per acre.

One further point is worthy of notice. There was every reason to believe that the hills in the two areas were equal as regards their vigour; the areas were within a few yards of one another, on the same soil and with the same aspect, and the hills were of the same age and variety and had received exactly the same manuring and cultivations. Actual proof, however, was obtained that the hills in the "seedless" area were *potentially* capable of producing as large hops as those in the "seeded" area. Earlier in the season two branches on the same bine of a hill in the "seedless" area were each put into a bag at the time just before the "burr" appeared; when the "burr" was fully out, the bag was removed for a moment from one of the branches only while some pollen-dust was applied to the "burr" by means of a small camel's hair paint-brush. The bags were removed from both branches some weeks later, by which time all traces of the "burr" had disappeared. At picking time the branch which had received no pollen on the "burr" bore small entirely seedless hops which had not "grown out," as shown in Plate XII.—the lower branch. The branch that had received pollen on the "burr" produced much larger hops, which were grown out properly and well-seeded (See Plate XII., the upper branch). These seeded hops, in fact—although they were gathered from hills in the middle of the "seedless" area—exactly resembled those gathered from the "seeded" area. The difference between the two can be seen clearly in Plate XIII.

There can be no doubt, then, that if pollen-dust had reached the "burr" throughout the "seedless" area, the hops there would have been equal to those of the "seeded" area. In other words we have additional proof *showing conclusively that it was the presence of pollen-dust alone which increased the crop in the "seeded" area to the extent of 4 cwt. per acre.*

We come now to consider the statistics which we have collected as to the amount of seed commonly grown in gardens in Kent and Surrey.

Table 12 is drawn up from the analyses of the samples of hops sent in to us from various sources, as mentioned above. We see, here, the amount of seed present in the various samples sent in in 1906 and 1907. It is not necessary to study this Table in detail, but we would draw attention to the following facts. Taking the season 1906 first, we see that in the cases where the hops were "not grown out" or "medium" the ratio of seeded to seedless bracteoles was 10 to 233, 10 to 46, 10 to 44, 10 to

TABLE 12.

District	Variety	Remarks	Average Number of Bracteoles per hop	Average Length of Hop in inches	Ratio of Seeded to Seedless Bracteoles
1906					
Wye	C'bury Whitebines	Not grown out; very poor crop	27	$\frac{9}{10}$	10 to 233
"	Early Birds	"	27	$1\frac{1}{10}$	10 to 46
Faversham	Goldings	Medium	27	$1\frac{3}{10}$	10 to 44
"	"	"	28	$1\frac{2}{10}$	10 to 41
Wye	"	"	27	$1\frac{1}{10}$	10 to 40
Petham	Petham "	Hops grown out	27	$1\frac{2}{10}$	10 to 25
Wye	Goldings	Selected hops, 2in. long or over	53	$2\frac{1}{10}$	10 to 16
Faversham	Mercer's "	Hops well grown out	25	$1\frac{2}{10}$	10 to 15
"	Goldings	"	26	$1\frac{5}{10}$	10 to 12
"	Mathons	"	28	$1\frac{3}{10}$	10 to 10
Puttenham, Surrey	F'ham Whitebines	A selected branch of large hops	26	$1\frac{7}{10}$	10 to 5
1907					
Wye	Goldings	Not grown out	28	$\frac{7}{10}$	10 to 495
"	"	"	28	1	10 to 137
Maidstone	"	Hops small	23	$\frac{8}{10}$	10 to 77
"	"	Hops grown out	33	$1\frac{4}{10}$	10 to 26
Wye	"	"	33	$1\frac{3}{10}$	10 to 25
Wingham	Bramblings	Badly grown out	20	$\frac{8}{10}$	10 to 21
Faversham	"	Small to Medium	24	1	10 to 19
Wye	Goldings	Hops grown out	27	1	10 to 18
Wingham	Bramblings	Medium	25	1	10 to 16
Farnham	F'ham Whitebines	Hops well grown out	30	$1\frac{3}{10}$	10 to 15
Bodiam, Sussex	Mathons	"	28	$1\frac{2}{10}$	10 to 14
Farnham	F'ham Whitebines	One of the best gardens of the year	35	$1\frac{4}{10}$	10 to 9
Puttenham, Surrey	"	Hops well grown out	28	$1\frac{3}{10}$	10 to 5

41, or 10 to 40. When the hops are "grown out," the ratio becomes 10 to 25; when the hops are "well grown out" it is 10 to 15, 10 to 12, or even 10 to 10; while in the case of a selected bunch of large hops the ratio becomes 10 to 5.

Turning to the season 1907, exactly the same kind of evidence is forthcoming.

In a good typical branch of well grown out Golding hops, such as is shown in Plate XV., each hop will be composed of about ten seeded bracteoles to fourteen seedless bracteoles. Some of the hops we have analysed, which came from some of the best gardens in Kent (and for which probably top prices were obtained), were found to show the ratio of ten seeded bracteoles to ten seedless bracteoles, or, in other words, fifty per cent. of seed was being grown.

In the earlier days it was the general rule in England for growers to plant plenty of male hops, and the big prices that have been paid for hops in the past have been paid for hops containing a good proportion of seed.

We will now consider a point which has probably already crossed the mind of many readers. It is one which is often brought forward in a question such as the following: "Why should not hop-growers [in this country] copy the example of their Bavarian competitors, and, by expelling all male plants from their gardens, produce a crop of greater value per cwt."*

Now the answer to this is that it is not possible in the case of the Golding varieties of hops grown in this country to produce a crop of seedless hops which are "grown out," and buyers will not look at small English hops which are not properly "grown out." The large Bavarian hops which are grown practically without seed are very different *botanically* from the English varieties of hops. To make a big hop without seeds a very large number of bracteoles is required; the German hop possesses this large number, but the English hop does not. An examination of our analytical tables shows us that taking all the samples which we analysed, the average number of bracteoles per hop in the Golding varieties was 27 in 1906, and 28 in 1907; the average number of bracteoles per hop in the German varieties which we have examined was 44. In the

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* From a letter, signed "Farmer and Brewer," which appeared recently in *The Standard*.

Fuggles' hop the average number of bracteoles per hop was 28 in 1906, 24 in 1907; in Cobb's Golding 25 in 1906, and 28 in 1907.

The difference in the composition of a typical English and a German hop is shown very clearly in Plate XIV.* We see that the German hop is more compact and denser, with more numerous closely-packed "petals," and is seedless; the English hop is composed of fewer "petals," arranged more laxly, and is seeded. Before we can think of growing a seedless hop in this country—though we do not for a moment suggest that it is desirable that we should do so—the grower must be provided with some new varieties of hops which will produce on an average forty or more bracteoles per hop instead of the twenty-four to twenty-eight bracteoles, which is the average number produced by the English varieties under the present methods of cultivation.

Let us now consider the comparative values of "seeded" and "seedless" hops. This, of course, is mainly a brewer's question, but the grower is indirectly concerned.

If we consult the various writers on the subject in different countries we find a great diversity of opinion. In an interesting paper † which appeared lately in a French journal the whole subject is reviewed from the Continental standpoint. The value of fertilisation in increasing the crop is admitted; it is stated, for instance, that in some cases seeded hops attain double the size of those of the same variety which have not been fertilised and are therefore seedless. Then the author points out that for making the beers of the Continent seedless hops are preferred by the brewers, and the statement is made that if many seeded hops are used the beer has never the same fine quality as when seedless hops are used. The official opinion on the Continent generally seems to be that the presence of the male hop is injurious, and in many districts laws have been made for the express purpose of exterminating male hops. Thus in the Spalt district—the most famous hop-growing district in Bavaria—any grower who allows a male hop to exist in his garden is liable to a severe penalty. In Belgium a similar law was passed in 1887; in France, too, the destruction of male hops has been ordered by the Authorities. The evidence collected by a Commission, composed of growers and brewers, to investigate hop-growing in the North of France, was believed to show that the influence of the male plant was not injurious to the "white-" and "green-bine" varieties as grown in France, but that in the case of the "red-bine" variety the production of seed "spoilt the look of the hop." In Belgium some growers favour the planting of a male hop to every 150 or 200 hills, saying that it improves both the quality and the quantity of the crop. The author states that the English grower regards it as advantageous to have one male hop to every 100 hills; and, finally, comes to the conclusion that it will be best for the French grower, too, to have a few male hops scattered through the garden.

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* We are indebted to Mr. W. H. Hammond, of Canterbury, for kindly lending us the photograph from which this Plate was prepared.

† "Faut-il planter du houblon male?" (*Journ. d'agric. prat.*, 1907, p. 166).

In America the value of the male hop is already fully appreciated. In a Bulletin of the United States Department of Agriculture on "Hop Culture in California," published in 1900, we read: "In America a small proportion of the plants planted in every garden are male,—the presence of seeds in the hop being considered by the grower an advantage." In a book called "The Hop," written by Myrick, the statement is made: "In America a male hill is planted for every 100 female hills."

In the midst of all these various contradictory statements, the English grower need only remember, we think, that at the present time the top prices are as a matter of fact paid for those English hops which are well grown out and seeded.

In conclusion, we should like to make a few practical suggestions with regard to the actual planting of male hops. One male to 100 female hills is amply sufficient; if the male hill is strong and vigorous, one to 200 or 250 is in all probability sufficient. The male hops should be planted regularly throughout the garden, and it is a good plan to plant a number of males in the lew row on the S. and W. sides of the garden, because the S.W. wind is the prevailing one at the time of year when the hops are in "burr," and when the male hop is scattering its pollen-dust on the air.

A very important point to which we would call attention is that the male hop to be of any use in the garden must produce its pollen at the time when the particular variety of hop with which the garden is planted is in "burr." It is not enough just to plant male hops in a garden; the males must flower and keep on producing pollen-dust all the time that the hops around are in "burr." It is most frequently the case that the male hops which appear spontaneously in gardens shed all their pollen and go out of flower before the surrounding hops are in burr, or have completely passed through that stage.

We have now in the male hop-garden at Wye College different varieties of male hops which flower successively from the middle of July to the end of August. We have discovered one male which is in flower even so late as the beginning of September.

We shall be pleased to give any grower a cutting from any male hop, selected to flower either early, medium, or late,—so that he can grow it, and reproduce enough plants by cuttings from it to plant up any particular garden in which the hops have not "grown out" properly.

We should like to mention here two points which are sometimes brought forward by growers as evidence that the presence of male hops has nothing to do with the hops "growing out."

First, it is often pointed out that in some gardens in which male hops occur plentifully the hops do not grow out properly. We believe that in such cases it will be found on investigation either that the male hops have flowered too early, so that there is no pollen-dust about at the time the hops are in "burr," or, that the bines, through some fault in manuring or cultivation, are not producing a sufficient number of "petals" per hop to produce a large hop even under the stimulus of fertilisation. All cases where the hops do not grow out properly are worthy of special investigation, and we shall be very pleased in the coming seasons if any grower in Kent or Surrey whose crop is affected in this way will call us in to look at the garden.

Secondly, it is pointed out that in very many gardens in which there is not a single male hop, the hops grow out well, and a very heavy crop is obtained. From this fact, which is unquestionable, it is then assumed that the garden has been free from the influence of any male plants. But in all cases it will be found,—according to our experience—that these hops if well grown out contain plenty of seeds, and it is a botanical fact that under no circumstance can a hop seed be produced without the " burr " having been fertilised by pollen-dust from a male hop. What has happened is that pollen-dust has been blown into the garden in question from male hops in neighbouring gardens or in the hedges. Pollen-dust is extremely light and is carried by the wind a considerable distance. In districts where there are acres of hop-gardens close together, such as round Sittingbourne, Faversham, etc., it is almost certain that the " burr " in any garden in which no males occurred would be fertilised by pollen-dust carried into the garden on the wind. Evidence that hops have not been fertilised by a male hop is *not* to be found in the absence of male hills in the garden, but only in the absence of seed in the hop. When, however, the garden in which no male hops occur is more or less isolated and without neighbouring gardens, or male hops in the hedges, we find, as a matter of fact, that no fertilisation occurs and the hops do not grow out properly. We saw above that in the College garden, which stands in an isolated position, the hops in the season of 1907 never grew out at all in those parts where a male hop was absent.

It would be interesting to ascertain whether the fact that the cultivation of hops is successful only in certain districts in England is in any way due to the prevalence there of pollen-dust in the wind in consequence of a large acreage of hop gardens. We would certainly advise any grower who is planting up a new garden at a considerable distance from existing ones to take special care to provide it with sufficient male hills.

One final word. We are anxious that we should not be misunderstood on this point. We are not advising you to grow more seed all round. The statistics which we have collected show that in well grown out hops taken from some of the best gardens in Kent and Surrey the amount of seeded bracteoles may be 50 per cent. or even exceed it.

You are growing plenty of seed in the gardens where the hops grow out well. But we do advise you to plant male hills, and so grow more seed, in those gardens where the hops have not grown out well,—because a well-grown hop is absolutely necessary to make a good (dried) sample, and English hops—or at any rate the delicate Golding varieties—do not grow out well unless the " burr " has been fertilised by pollen from a male hop, so that the ripe hop contains a fair proportion of seed."

One very important point remains for consideration, *viz.*, the amount of resins ("lupulin") contained in, respectively, "seeded" and "seedless" hops. Analyses were made of the "seeded" and the "seedless" hops gathered from the one-seventh acre areas in the College hop-garden (see above, p. 379).

The method* employed was as follows. Approximately four grammes of hops were taken and placed in filter-paper cartridges. These were dried in an atmosphere of coal gas in a steam oven for forty-eight hours, and then weighed to determine the actual weight of dry hops. The cartridges were then completely extracted with petroleum ether, dried and weighed. The loss in weight showed the amount of *soft resin.* Finally, the cartridges were extracted with methylated ether, dried and weighed. The loss in weight showed the amount of *hard resin.* In each case duplicate analyses were made. The results obtained were as follows :—

	Percentage of soft resins.	Percentage of total resins.	Total resin per acre.
Hops from "seeded" area ..	10	15	147 lbs.
Hops from "seedless" area ..	12	17.2	92 lbs.

That is to say, the "seedless" hops contain a greater *percentage* both of soft and of total resins than the "seeded,"—a result entirely in accordance with anticipation, since in the one case we have seeds and in the other none.

Taking the third column in the above table (the total resin per acre), obtained by calculation from the crop produced in the two areas (8¾ cwt. per acre from the "seeded," and 4¾ cwt. per acre from the "seedless") and the percentage of total resins, we see that the amount of resin per acre produced by the seeded hops is 147 lbs. as compared with 97 lbs. by the seedless hops; or, in other words, *the result of fertilisation was to increase the amount of resins grown by more than one-half.*

The results obtained were re-calculated to show the ratios between the resins contained in "seeded" and "seedless" hops, and it was found that the ratio of total resins between the seeded and the seedless hops is 100 to 115, or in other words, 100 lbs. of "seedless" hops are equivalent to 115 lbs. of seeded hops so far as their resin content is concerned.*

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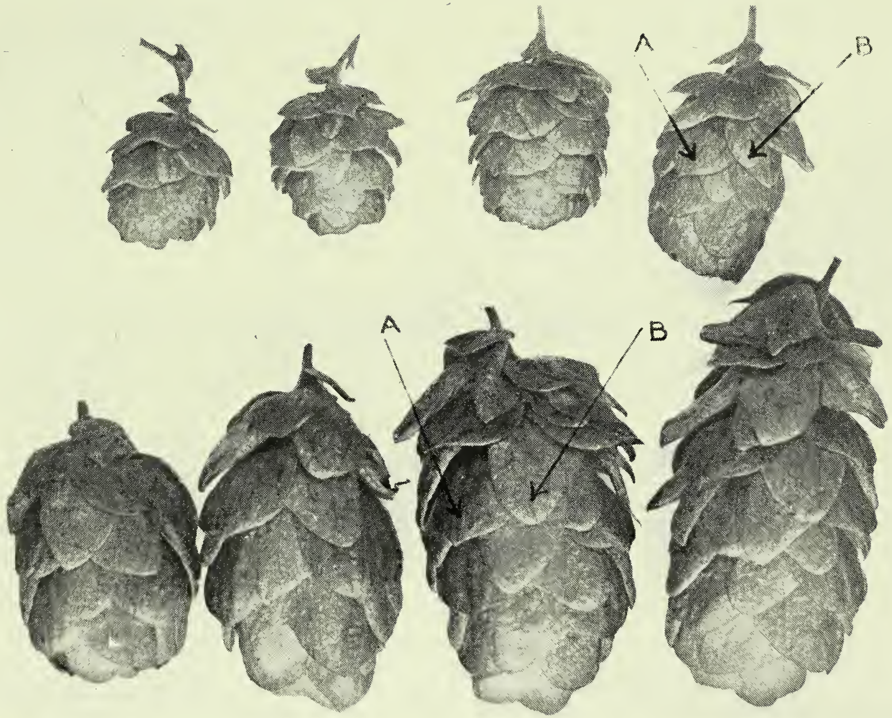
* The method adopted was a modification of that described by Bryant and Meacham in *Journ. Fed. Inst. Brewing*, 1897, p. 233.

There are, however, many other characteristics of seeded and seedless hops to be taken into consideration, and their comparative importance estimated from the brewer's standpoint. The value of the hop for the brewer cannot be estimated solely by the amount of "resins" the hops contain. There are many other characteristics of great importance which the brewer wants to see in the hop. For instance, for brewing purposes, a large well grown out and whole hop is of more value than a small hop. We would recall here the fact that—so far as our experience goes,—the large well grown out Golding hop is always seeded. Again, "seeded" hops are certainly brighter in colour than "seedless" hops.

In order to obtain first-hand information from the brewers we presented a paper,—containing all the above mentioned facts—for the consideration of members of the Brewers' Institute at meetings held during the winter of 1907-8 at London, Birmingham, Manchester, and Leeds. In the full discussion evoked by the reading of the paper we learnt the opinion of the brewers, as well as of brewers' chemists, as to the comparative value of "seeded" and "seedless" hops for use in brewing the beers of this country.

We may summarise the information we obtained as follows. Whilst it is clear that brewers and brewers' chemists do not know very definitely what they want to find in hops, they believe that the "resins" are one of the most important constituents. With regard to the question of the advantage of the presence or absence of seed in the hop, opinion is very much divided. It seems clear that no chemically deleterious substance is contained in the seed itself. Some brewers are indifferent as to the presence or absence of seed; some look upon the presence of seed as a "nuisance," as being liable to get in the way in some of the processes of brewing; while some firms (of well-known brewers) prefer to see plenty of seed as an indication of a well-developed sound hop. As one of

* It is interesting to note that these ratios approximate closely to those of Prof. Schroder for the "lupulinic content" in German seeded and seedless hops. Prof. Schroder's figures, published some years ago, showed that the ratio between the seeded and seedless hops was 100 to 116.

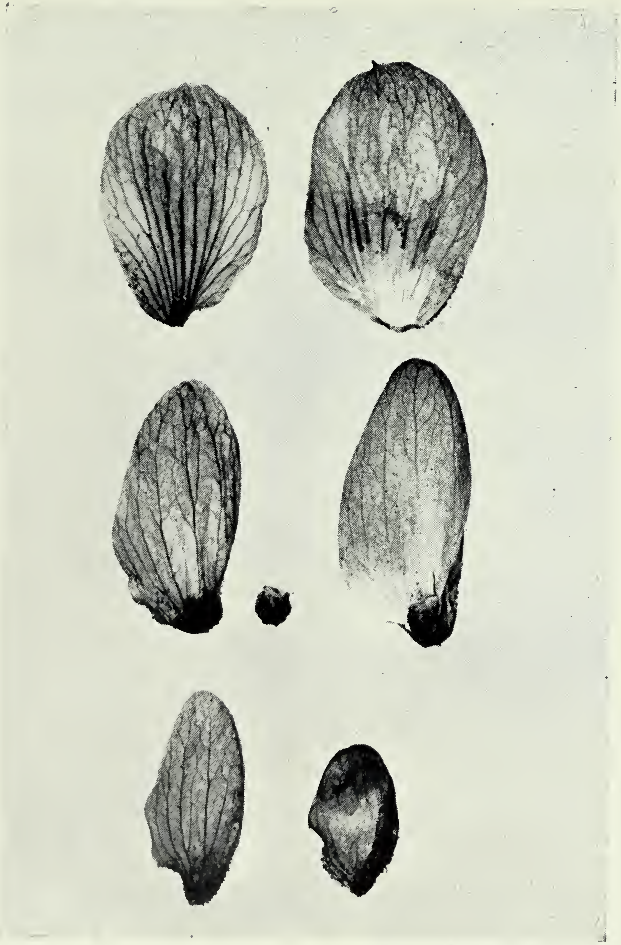


[*W. H. Hammond, photo*

PLATE I.

SEEDLESS AND SEEDED GOLDING HOPS (Canterbury Whitebines). The seeded hops are in the lower row.

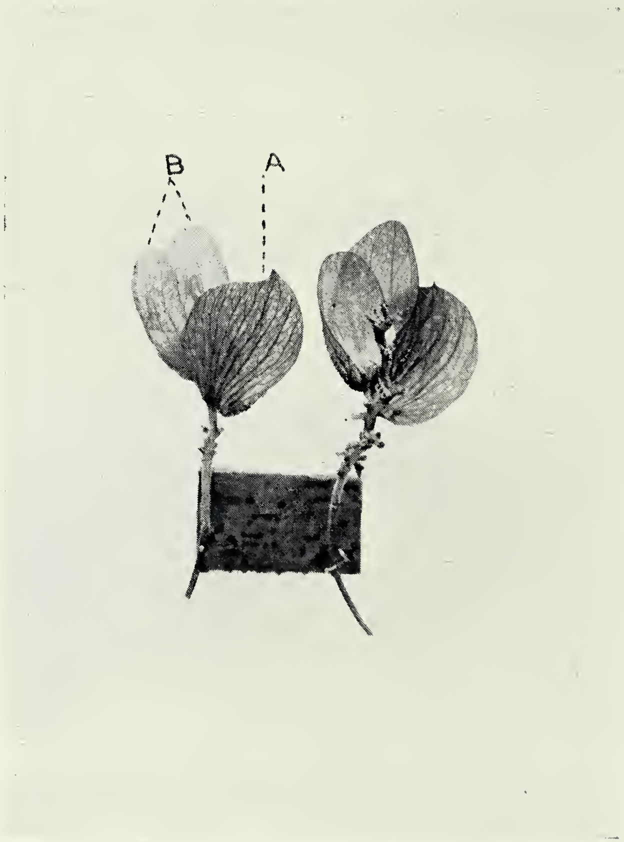
A, a *bract* ; B, a *bracteole.*



[*W. H. Hammond, photo.*

PLATE II.

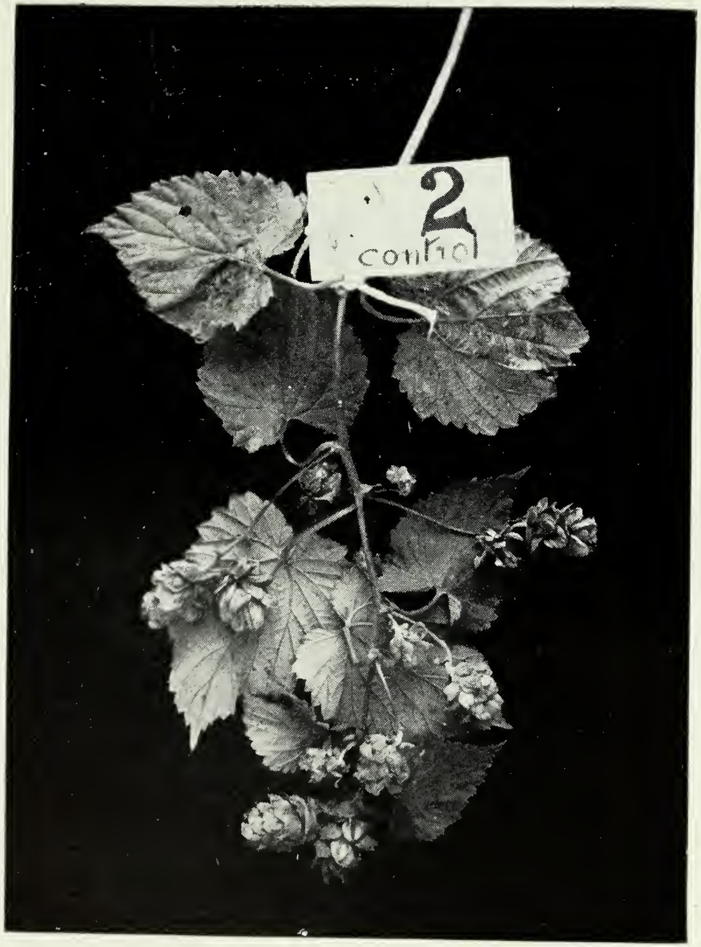
Top row, two *bracts*; middle row, two *seeded bracteoles*, and a detached seed; bottom row, two *seedless bracteoles*.



[*W. H. Hammond, photo.*

PLATE III.

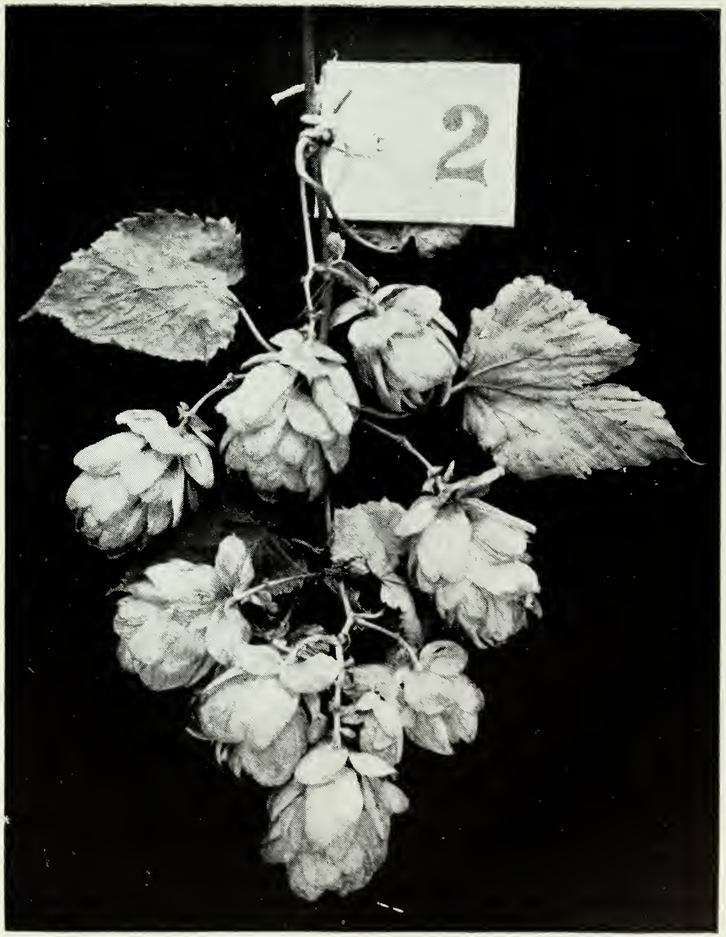
A hop dissected to show the position of the *bract* and *bracteoles* on the strig; back and front view. A, the *bract*; B, the two *bracteoles*.



[W. H. Hammond, photo.

PLATE IV.

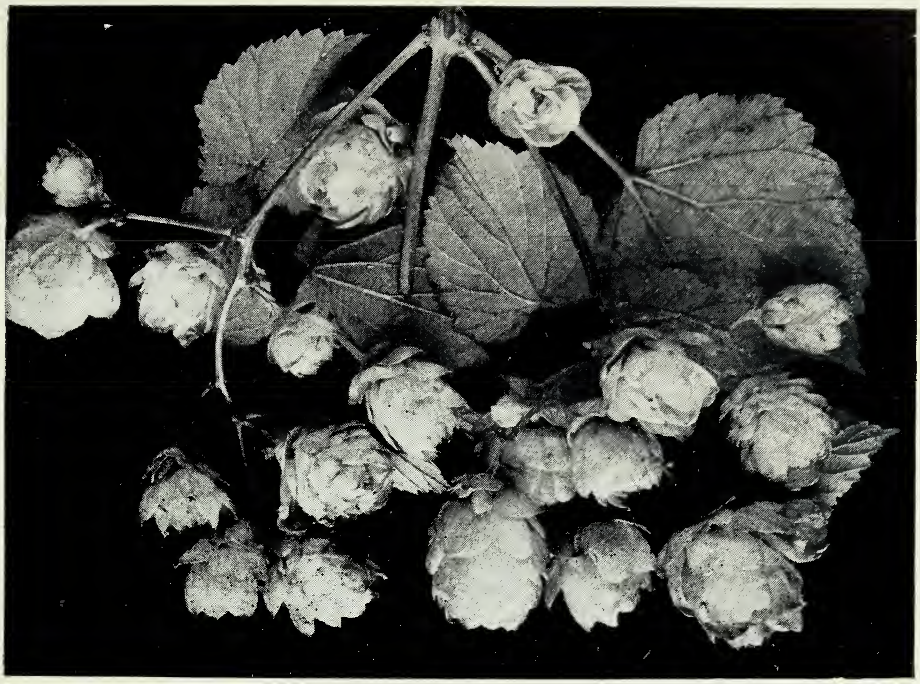
A BRANCH OF SEEDLESS GOLDING HOPS



[W. H. Hammond, photo.

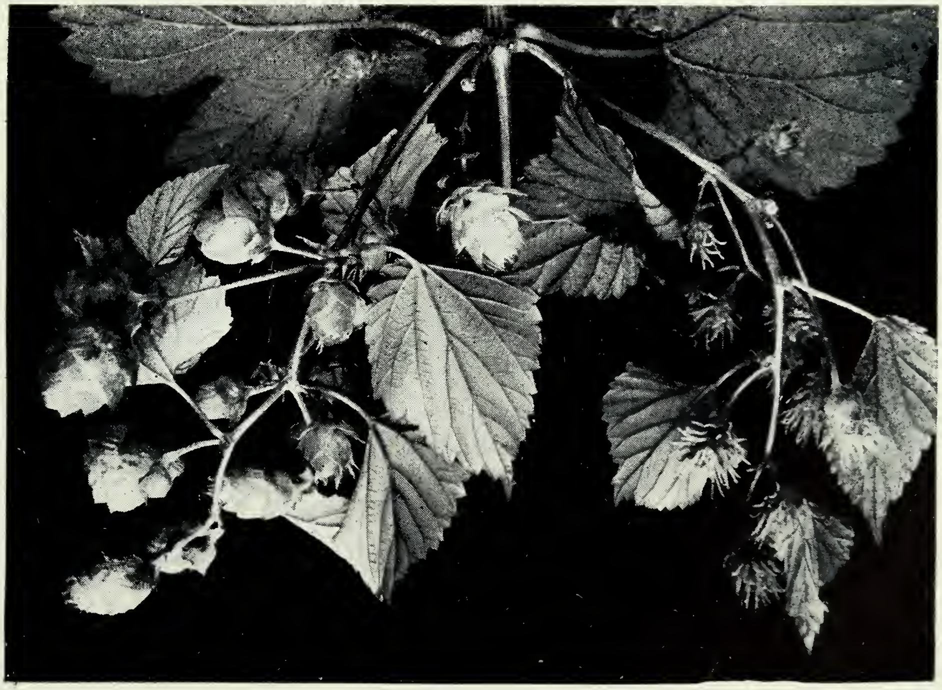
PLATE V.

A branch of seeded hops produced on the same bine and under identical conditions as those shown in Plate IV., except that pollen was supplied to the "burr."



[W. H. Hammond, photo.

PLATE VI.

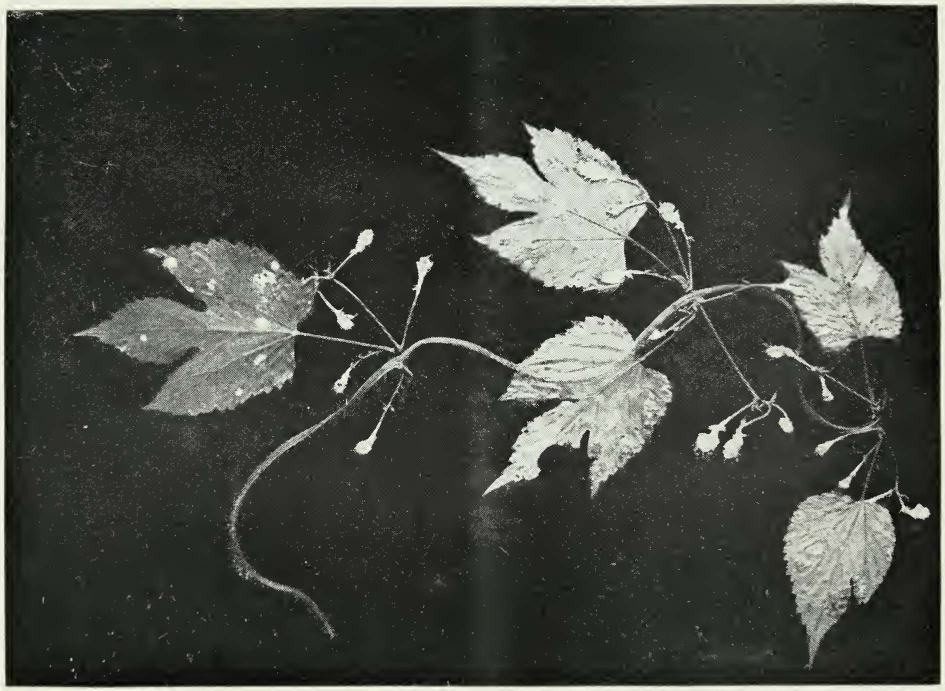


[W. H. Hammond, photo.

PLATE VII.

Two opposite branches of hops growing on the same bine; appearance on August 21st.

On July 27th both branches were in "burr;" in the branch shown in Plate VI. the "burr" was dusted over with pollen, while the branch shown in Plate VII. received no pollen.



[*W. H. Hammond, photo.*

PLATE VIII.

A branch of hops in "burr," badly attacked by "mould."

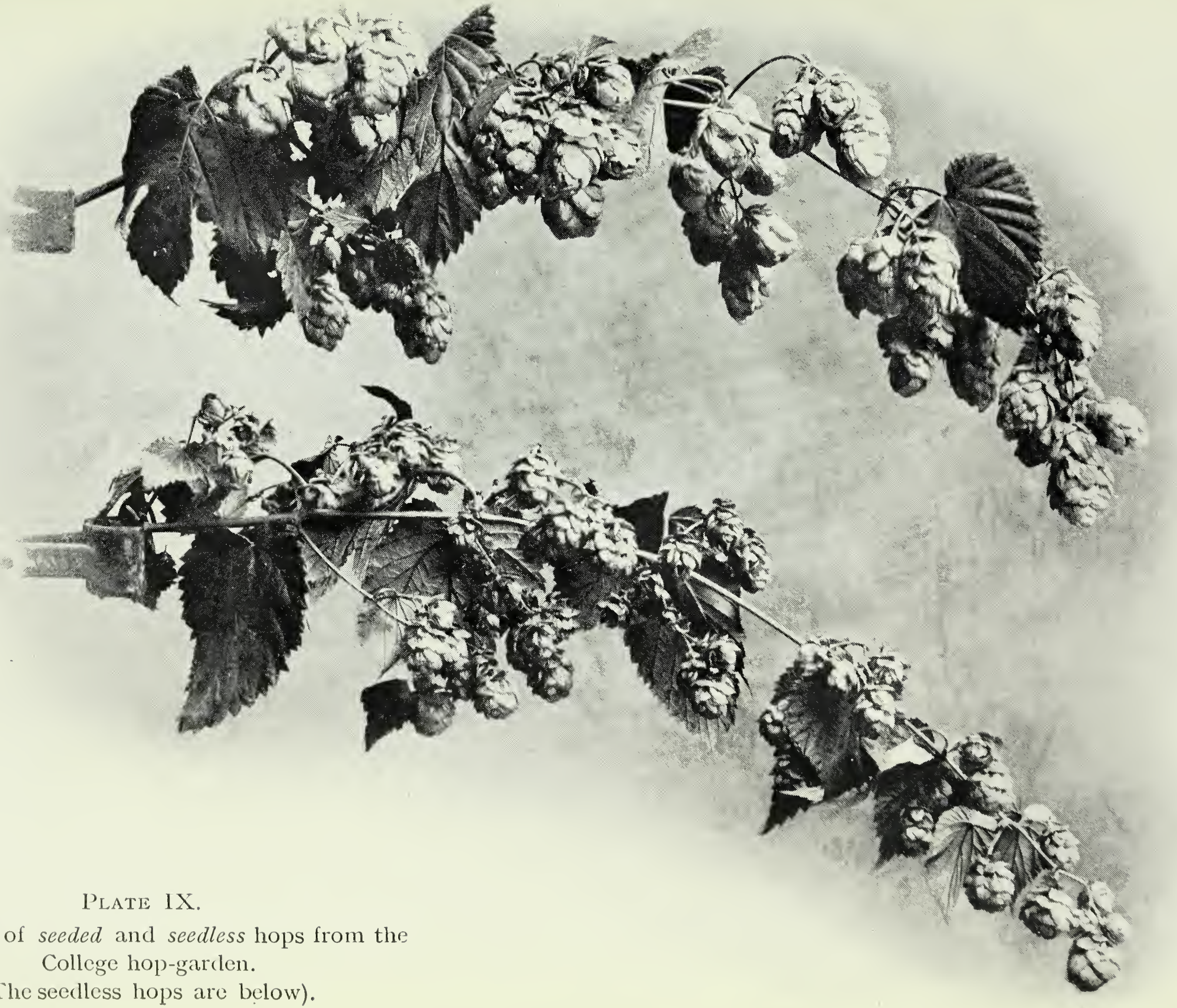
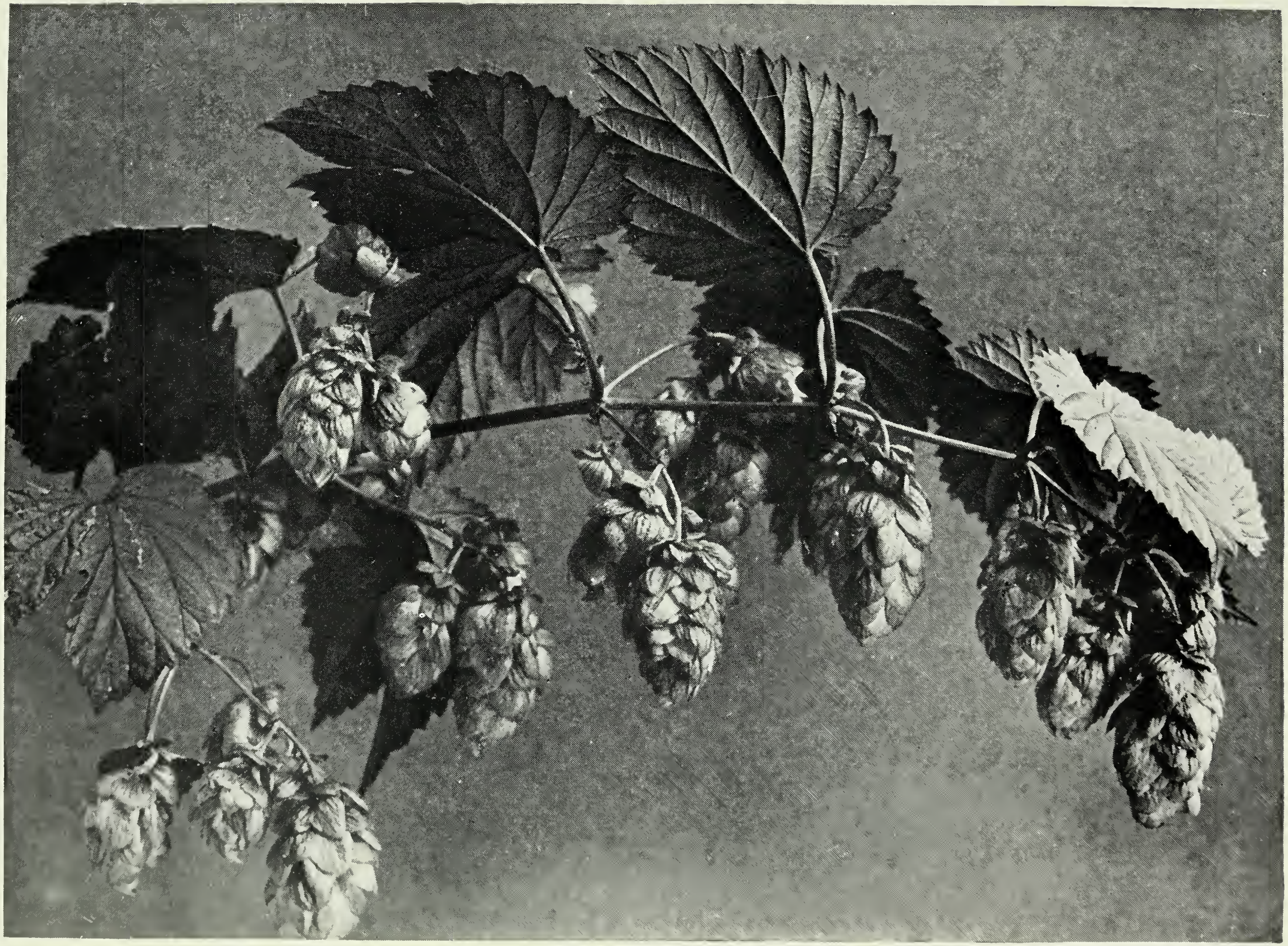


Plate IX.

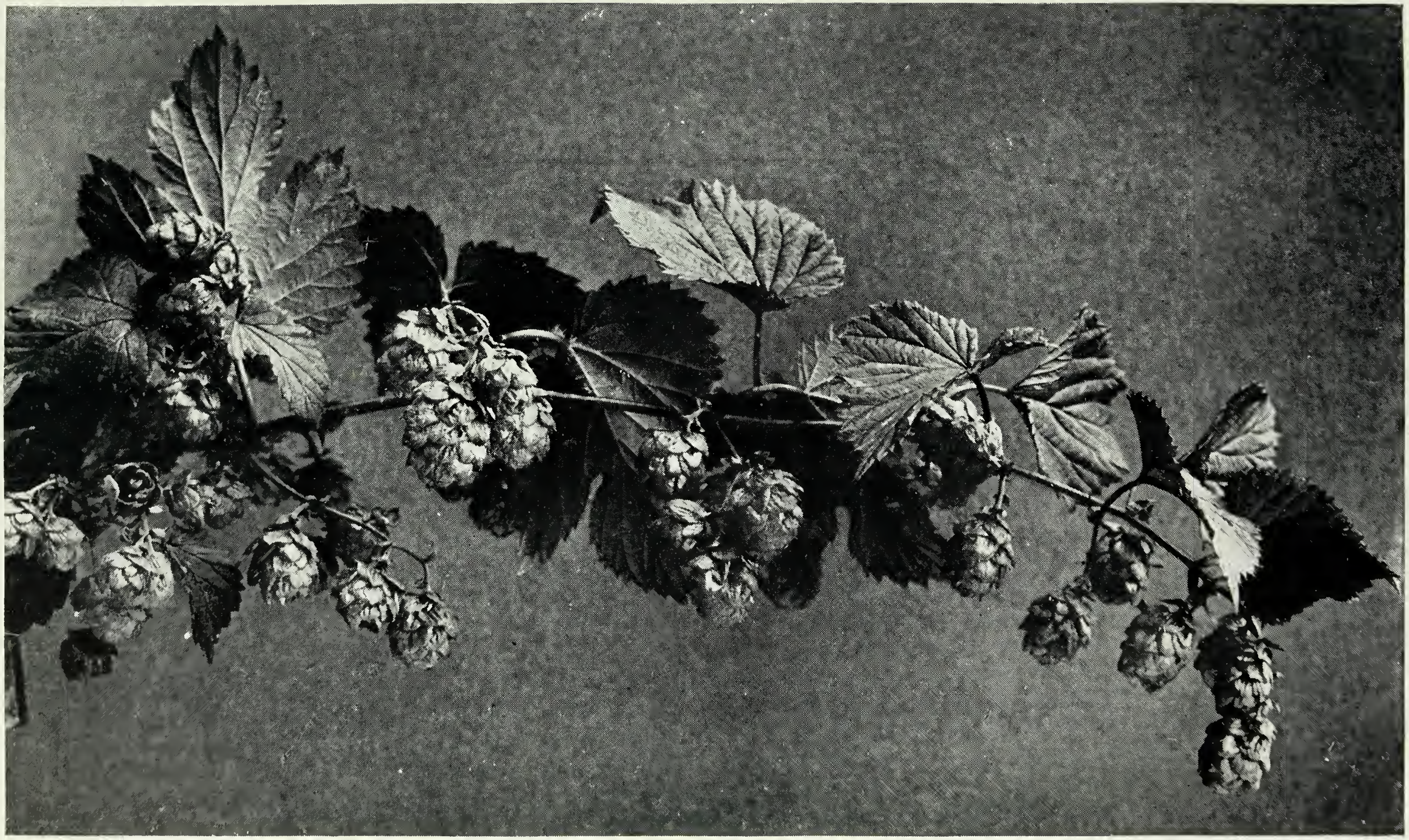
Branches of *seeded* and *seedless* hops from the College hop-garden.
(The seedless hops are below).



[*W. H. Hammond, photo.*

PLATE X.

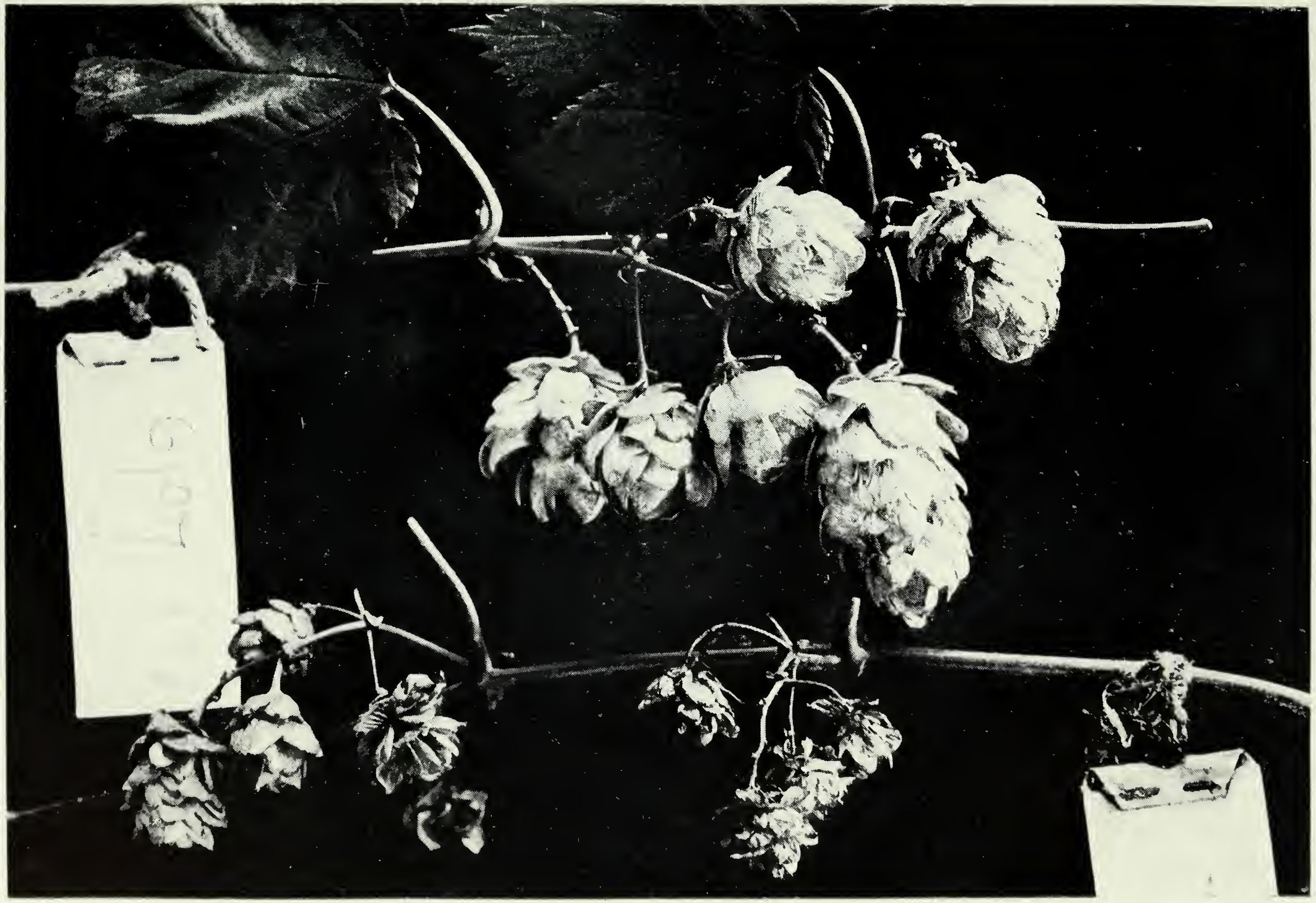
A branch of *seeded* hops from the College hop-garden.



[W. H. Hammond, photo.

PLATE XI.

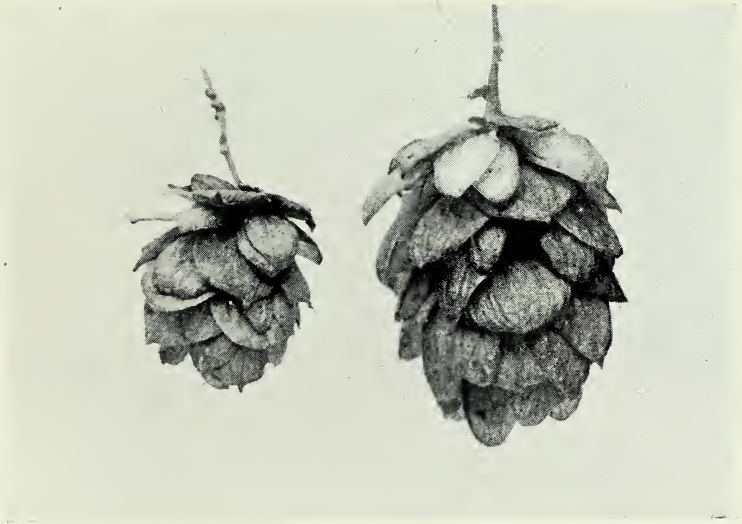
A branch of *seedless* hops from the College hop-garden.



[*W. H. Hammond, photo.*

PLATE XII.

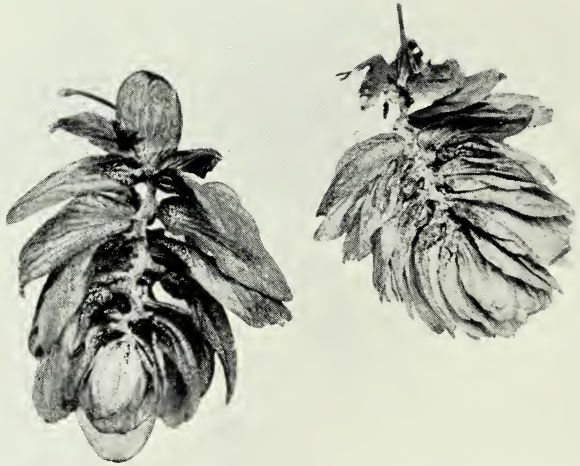
Seeded and seedless hops produced on the same bine (from the " seedless " area). (See page 382).



[*W. H. Hammond, photo.*

PLATE XIII.

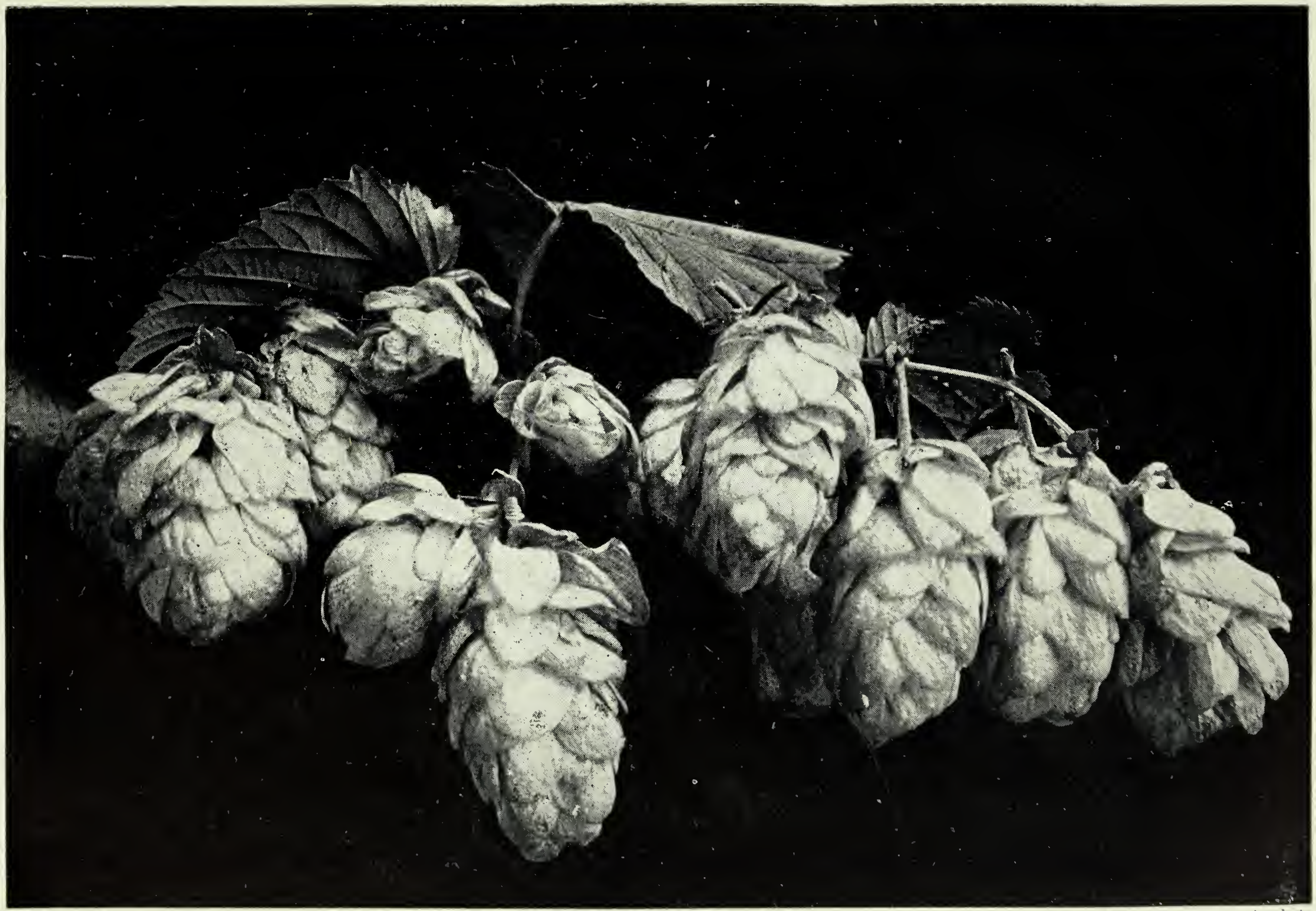
Seeded and seedless hops produced on the same bine. The seeded hop is on the right. (See page 382).



[*W. H. Hammond, photo.*

PLATE XIV.

An English and a German hop, cut in half to show the difference in the composition. The German hop is on the right. (See page 385).



W H Hammond, photo.

Plate XV.

A typical branch of well-grown-out Golding hops. The hops contain on an average ten seeds.

the most eminent of the brewers' chemists in London expressed it, there are no reliable data on the subject from the brewing standpoint, and it is at present a matter of personal opinion or conjecture or even of prejudice.*

But, writing for the grower only as we do here, we would conclude by pointing out the following facts as worthy of his special notice.

If the resin content alone is assumed to be the best test of the quality of a hop, it follows from the facts given above that the grower who plants male hops and so secures well grown out seeded hops is not fixing his attention upon bulk only, but upon bulk and quality at the same time.

To summarize the facts: the "seeded" hops (bearing on an average 9·5 seeds) contained 15 per cent. of resins, and produced 8¾ cwt. per acre; the "seedless" hops (containing ·5 seeds) contained 17·2 per cent. of resins, and produced (under identical circumstances) 4¾ cwt. per acre. That is to say, the "seeded" hops produced 147 lbs. of resins per acre, whereas the "seedless" hops produced only 92 lbs. per acre.

For English growers to attempt to grow at the present time "seedless" Golding hops, would be—we can state most emphatically from the facts in our possession—the most disastrous step they could take.

May, 1908.

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* The incontrovertible facts must not be forgotten that at the present time it is the well-seeded hops which command the best prices, and that when "seedless" hops are put on the market a much lower price is offered. Judges, too, almost invariably award the first prizes in competitions to well-seeded hops; we may instance the case of the almost fully seeded hops which carried off the Champion Cup at the show at Ashford in 1907.

ON THE RAISING OF NEW VARIETIES OF HOPS.

By E. S. Salmon, F.L.S., and Arthur Amos, B.A.

Of all the varieties of hops that are now being grown commercially in England, not one has been raised scientifically. Evidence on the subject was collected by Mr. J. Percival, when Professor of Botany at this College, and this shows that all the varieties of hops which are grown at the present day have originated as the result of some mere chance or accident. In most cases a single plant of unknown origin was observed to have some character different from the rest of the plants in the garden; from this plant cuttings were taken, and thus the variety was established.

The history of the hop called "Pretty Will" is a case in point. A shepherd (who was nicknamed "Pretty Will" on account of his ugly face) noticed a hop growing in his garden hedge; he took cuttings from this and planted them in his garden, and eventually sold them to a hop-grower for a few shillings; the hop-grower propagated from these until eventually he obtained enough plants to plant a garden.

In two cases only is it known for certain that new varieties have been raised from seed, although it is possible that several other varieties are of seedling origin; these two cases are :—(1) Bennet's Early Seedling, a hop of no great importance; and (2) the Fuggle, one of the most valuable varieties grown at the present time, possessing, as it does, great vigour and hardiness, which enable it to resist adverse conditions, and to produce large crops of hops.

The discovery of the Fuggle was again a matter of chance. About the year 1861, a hop seedling appeared in the flower-garden of a certain Mrs. Stace, of Horsmonden. Mrs. Stace was a hop-picker, and was wont to shake out her dinner-basket on this flower-garden as she came home from picking ; hop-seeds, doubtless, found their way into her basket, and so on to the flower-garden. A certain seed grew and produced a seedling ; sets from this plant were introduced to the public by Mr. Richard Fuggle, of Brenchley. The parentage of this variety is quite unknown.

It is interesting to note that the Fuggle is the most vigorous of the cultivated English varieties. It suggests the possibility that its vigorous constitution is due to its seedling origin, that is, to the fact that one generation has been propagated sexually instead of being continuously propagated asexually by means of cuttings.

It is by the above happy-go-lucky methods, essentially unscientific, that new varieties have been introduced in the past.

Let us compare this with what has been done as regards scientific breeding in the case of other crops. Among the large number of cases on record, we will take the case of the sugar cane in the West Indies, where new varieties are now being raised under the supervision of our Government.

Like the hop, the sugar cane is propagated by growers entirely by means of cuttings. During the last six or seven years many new varieties have been raised from seed. A few of these have proved much superior to their parents. The new seedlings possess increased vigour and growth, and on this account are better able to withstand a certain class of disease. Other seedling varieties, again, have been raised which produce a larger amount of sugar per pound of sugar cane.

In the United States, where the interests of Agriculture are exceedingly well looked after by the Government, a special Department has been created for the single purpose of breeding new and improved varieties of plants.

The objects of the highly trained staff of the Department are to produce plants which shall be : (1) more productive ; (2) of better quality ; (3) resistant to disease.

From their many successes we will quote one case. For some time back water melons had been grown to a large extent in various parts of the United States. Then a soil disease (a fungus which attacked their roots and finally killed the plants) appeared, and spreading rapidly, rendered the growth of the ordinary varieties impossible. At this stage the United States Department of Agriculture took the matter in hand. First, a strain of water melons was found which proved resistant to the disease. The fruits of this strain, however, were very inferior in quality.

The next step was to use this disease-resistant variety as one of the parents in a series of crosses, using for the other parent one of the many varieties of melons with high quality fruit, but susceptible to the disease. A large number of crosses were thus made. The seeds resulting from these crosses were planted, and gave rise to about 1,000 varieties of all sorts of melons, long and short, smooth and rough, high quality and low quality. Of these varieties a number proved resistant to the disease, but only six were considered worthy of further trial (the rest being discarded for inferior quality or other defects.) Seeds from these six varieties were saved and planted the following year. They all remained resistant to the disease, and one proved to be a satisfactory melon commercially.

As is well known, the potato is another plant which has been improved from time to time by propagation from seed.

Hundreds of cases, in fact, show that it is possible by breeding to obtain new varieties which are superior to their parents ; (1) in quantity and quality of crop ; (2) in powers of resisting disease. They show further that one must not expect to obtain the desired results by raising a few seedlings, but that it may be necessary to raise hundreds, or even thousands, of seedlings before the work is accomplished.

Turning now to Hops, the time has surely passed when we in England should trust to chance for obtaining new varieties. Mr. A. Howard, when at Wye, held this view, and started to raise new varieties scientifically from seed. For the past two years we have been continuing his work.

Hop seeds are only produced when pollen-dust from a male hop* falls upon and fertilises the " burr " of a female hop ; it is therefore obvious that in breeding new varieties, we must have a selection of male hops. We have now set aside at the College a small garden, in which we are growing male hops, with widely different characters.

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* A male hop is often called a " seeder " by growers.

The characteristics of these male hops are carefully observed and recorded, so that when we want a male hop with a given set of characters, for crossing purposes, we shall know where to find it.

Hopgrowers can help us greatly in our work by sending us cuttings of any male plants they find, which show any marked characteristic (such as great vigour, earliness or lateness in flowering, or freedom from disease).

The method which we have adopted for obtaining crosses is briefly as follows:—two growing lateral branches are tied up separately in two white paper bags, a few days before the hops come into burr; a piece of cotton-wool is first wrapped round the stalk—at the place where the string is to be tied—to prevent the entry of pollen and insects, and to protect the stalk itself. The branches are left in the bags till in full burr, when one bag is taken off, and pollen dust (taken from the selected male hop) is gently dusted over the burr with a soft paint-brush. The bag is quickly replaced, and left on until the burr has dropped from both branches, when the bags are removed and the hops left to ripen.

When dead ripe the hops are picked, and the seeds collected from the pollinated branch; at the same time the hops from the non-pollinated branch are examined, and if there are no seeds present in these we can safely conclude that the selected male hop is the male parent of the seeds in the hops on the pollinated branch.

The seeds so obtained are sown in March. Under favourable circumstances the seedling may yield a few hops in the second year, and nearly a full crop in the third year. Thus a considerable time has to elapse before definite results are obtained.

In 1907, some twenty plants of the seedlings raised by Mr. Howard produced a crop of hops, sufficient to give us some idea of their characteristics. They are being tested along two lines: (1) their vegetative characters (such as vigour, colour of bine, shape and size of hop, arrangement of hops on the laterals, crop, resistance to disease) are first studied, and if these characters are satisfactory, then we proceed to the second test. (2) A dried sample is submitted to competent judges for their opinion as to its quality. The percentage of preservative resins is also determined chemically in order to obtain a measure of the brewing value.

If the plant is satisfactory both as regards vegetative characters and brewing value, cuttings are taken, and the variety tested upon a larger scale in the College garden.

When we obtain a variety that is satisfactory under these conditions, and is likely to be of permanent value, we shall ask for the assistance of growers through Kent and Surrey to test it upon the different classes of hop soils in these counties.*

Of the twenty seedlings raised by Mr. Howard, which produced hops in 1907, six were considered good enough to be dried separately. Of these seedlings, two are crosses between the Canterbury Whitebine, as the female parent, and a selected male hop; two have Colegates, one a Fuggle, and one a German variety (Saaz), as the female parent,—different selected males being the other parent.

The two seedlings from the Colegates produce fine, well-grown hops and their flavour is not nearly so coarse as that of the Colegate itself. One of the seedlings from the Canterbury Whitebine female crossed with a male hop growing in Mr. Clement's Golding garden at Eastwell also shows promise; these hops are medium in size, are set very close together on the laterals, and have a good flavour.

In view of the fact that it is often stated that ninety to ninety-five per cent of seedling hops come male, it may be of interest to record the actual number of males and females among the seedlings we have raised up to the present.

Out of 157 seedlings which have been raised, 129 are female, and only twenty-eight male, which seems to show clearly that the above statement as to the preponderance of males is wrong. It is not improbable that we shall find, when we have raised a sufficient number, that the proportion of male and female plants among seedlings will be equal.

The following is a list of the varieties we have used as the female parent in 1906 and 1907.

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* Farmers in Kent or Surrey who are willing to make trial of such new varieties are requested to send in their names to us.

In 1906.—Early Whites, Amos' Early Bird, Bramlings, Canterbury Whitebines, and a wild hop with good aroma (supplied by Mr. W. H. Hammond).

In 1907.—Early Hobbs, Prolifics, Canterbury Whitebines, Fuggles.

These have been crossed with various male hops. As yet, of course, the seedlings have not flowered. A report as to the characteristics of these seedlings will be given in a future number of this Journal.

In conclusion, there is one point we wish to emphasise. In plant breeding, just as in animal breeding, results can only be expected after a considerable lapse of time ; further, careful record must be kept of the characters of the parents and of the way in which these or other characters appear in the offspring. It is therefore obvious, that success is only likely to be obtained where there is continuity in the work extending over a number of years.

VETERINARY NOTES.

BY

T. W. CAVE, F.R.C.V.S.

DISEASES OF SHEEP.

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VETERINARY NOTES.

DISEASES OF SHEEP.

I.—" STRUCK " SHEEP EXPERIMENTS, 1907-8.

In previous years one of the difficulties already experienced in the prosecution of the " struck " sheep experiments, was the possibility that the specific organisms might lose their virulence during prolonged cultivation in the laboratory. This difficulty had cropped up at a season of the year when fresh supplies of flesh from " struck " sheep were not easily obtainable.

During the spring of 1907, a new stock of virulent material was obtained from Romney Marsh, and experiments were tried to find the best means of preserving the virus, so that at all times of the year fresh cultures of the bacilli could be prepared.

As the result of various trials, it was found possible to keep a stock of virulent material in such a way that it would be always available for use.

Improvements were also devised in the methods of obtaining pure cultures of the " struck " bacilli, so that it was now possible to prepare virulent cultures in the large quantities necessary for the preparation of vaccines, etc.

During 1907, preparations were made for the carrying out of a series of field experiments in Romney Marsh at the beginning of 1908.

These experiments were to be on the lines suggested by Dr. Hamilton, of the University of Aberdeen.

In 1906, the Board of Agriculture and Fisheries published a report of the Departmental Committee for the investigation of Braxy and Louping-ill, in which Dr. Hamilton placed on record the result of experiments made by himself and colleagues on the preventive treatment of these diseases of sheep. In Part III. of the report it is stated that :—

" A long series of experiments was conducted to discover if Louping-ill and Braxy could be prevented by subcutaneous inoculation of their bacilli. This method of procuring immunity by injecting the culture under the skin was found to be uncertain and unsatisfactory. The organism not being introduced into the intestine—its natural habitat,—but inoculated subcutaneously, often produced results which were violent, and sometimes ended in the death of the animal.

" At times, this method failed entirely to confer immunity, and whether successful or not, it enfeebled the sheep, causing uneasiness, lameness and loss of condition.

" The natural habitat of this group of bacteria being the intestine suggested the idea of ' drenching,' or introducing the organism by the mouth in preference to the method of subcutaneous inoculation.

" The results have proved eminently satisfactory. No pain, uneasiness, or loss of condition has been noticed, and in every way the new method has proved successful. These results were arrived at gradually. There were numerous failures, largely owing to ignorance of the seasonal variation of the blood, which was discovered only in 1904. The extraordinary success of the subsequent preventive measures proves the importance of the discovery.

" The drench which proved so effective, was prepared by incubating the specific bacteria on glucose-beef-tea, a small quantity of which mixed with water was administered to each sheep by the mouth, a second dose being given a week to a fortnight later.

" The drenching experiments were confined to Braxy and Louping-ill, but there is no reason to anticipate that successful results will not be obtained by a similar method of treating the other diseases of the same group."

Dr. Hamilton also records his explanation of the seasonal nature of Louping-ill and Braxy, and allied diseases. He has found that during the greater part of the year the blood of healthy sheep has a distinct bactericidal action, and will destroy the specific organisms which are the active cause of these diseases. But at the particular season, during which each of these diseases is prevalent, the blood has lost its bactericidal power, and consequently the sheep succumb to the attacks of the microbes. Also that " those sheep, which, when grazing, pick up the organism during the season when they are not susceptible (viz., when the blood can destroy it) usually allow of its passage along the intestine without detriment, and are evidently thus rendered immune, so that when the period of danger arrives they fail to take the disease.

" On the other hand, sheep which pick up the organism for the first time during the dangerous period (*viz.*, when the bacillus can grow upon the blood) have little power in resisting the passage of the organism into the peritoneal cavity, and consequently many of them fall victims to the disease."

As has already been shown, the subcutaneous method of inoculation against " struck " was tried by me on a number of sheep in Romney Marsh several years ago, and it was then found that whatever degree of protection might be given to the inoculated sheep, the loss from inoculation was too great to allow of the method being continued.

When, therefore, Dr. Hamilton's method of " drenching " sheep with virulent cultures of the Braxy and Louping-ill organisms was brought to my notice, it seemed possible that the method might have useful results in protecting the sheep of Romney Marsh against the attacks of the " struck " organisms, and it was decided to give the method a trial.

Dr. Hamilton very kindly gave me his advice as to the carrying out of the method, and suggested that the dosing of sheep with the cultures of the " struck " organism might be done in the month of January.

As is well understood, the disease in sheep known as " black-quarter " or " struck " generally prevails early in the year, and during March, April and May heavy losses are experienced in all parts of Kent, but especially in the rich grazing district of Romney Marsh. From the end of May onwards to the end of the year only sporadic cases occur, although one must suppose that sheep have access to the microbes while grazing at all seasons of the year. One may therefore conclude that during the greater part of the year sheep are but little susceptible to the deadly effects of the "struck" bacillus, and that they owe their immunity to the bactericidal power of the blood, as described by Dr. Hamilton.

Also it seems possible that as sheep grazing in Romney Marsh are at all times liable to pick up the organism, those which do so during the safe period become immunised, and are able to resist infection during the dangerous season.

On the other hand those sheep which enter the dangerous period of the year while still susceptible, probably soon succumb to the microbes.

If, then, one can make sure that all sheep about to enter the dangerous season have already had introduced into their intestines a sufficient dose of the bacilli to render them immune, one may hope that sheep so immunised would withstand the attacks of the microbes when the dangerous season arrived.

The series of experiments now reported was based upon the above theories, advanced by Dr. Hamilton, and was conducted in Romney Marsh. I have again to express my indebtedness to Mr. Arthur Finn for so kindly placing his flock at my disposal for these experiments.

During January, 1908 (between the 3rd and 21st), 255 sheep were twice dosed with cultures of the "struck" bacillus, grown in glucose broth. The second dose was given from a week to a fortnight after the first. No ill effects were seen in any of the treated sheep. The sheep were specially marked for future identification, and were mixed with untreated sheep grazing upon known dangerous land.

Records of all deaths in treated and untreated sheep were carefully kept, and the reports of the shepherds were sent in to me on July 17th last. At first sight it seemed as if no definite information could be obtained from the experiments as the number of untreated sheep was constantly changing during April and May, and it was found to be impossible to compare the percentages of deaths in the two lots.

A careful analysis of the records showed, however, that from January 21st to March 21st, a period of two months, no deaths occurred amongst the *treated* sheep, while in the *untreated* lot for the same period, fourteen sheep were " struck."

From March 21st to the end of June, when the records were made up, twelve out of the 255 sheep which had been dosed in January, were found to have been " struck." During the same time, forty-seven untreated sheep were " struck," but no comparisons are possible, owing to the changes in numbers in the untreated sheep above mentioned.

It is, however, perfectly clear that a certain degree of immunity was obtained in the treated sheep, no deaths having occurred for two months after " drenching," while in the untreated sheep fourteen were " struck " during the same period.

At the end of two months the treated sheep appeared to be again susceptible, and twelve of them died from the disease before the close of the experiment. It is somewhat disappointing that more definite results have not been obtained, but the small measure of success attained encourages one to hope that in future experiments, a greater degree of immunity may be secured.

Future trials will show whether better results may not be obtained by slight modifications of the present method, such as " drenching " the sheep a short time later, or possibly by giving larger doses of the cultures.

The doses given were somewhat smaller than those suggested by Dr. Hamilton, but it was necessary to proceed cautiously, for fear that harm might be done by over-dosing.

In conclusion, I have to express my thanks to Professor Hamilton for his valuable advice, to Mr. Arthur Finn for the help he is always ready to give me in the carrying out of my experiments, and to Mr. C. H. Popham for the assistance he has given me in the preparation of the doses in the laboratory, and also in " drenching " the sheep, which was often done under very uncomfortable conditions and in all kinds of weather.

2.—AN INVESTIGATION INTO THE NATURE AND CAUSE OF "SWAY-BACK" IN LAMBS.

An investigation into the nature, cause, and preventive treatment of this curious disease has been made during the past year. As far as my information serves the disease appears to be peculiar to Romney Marsh. It is popularly supposed to be due to a malformation of the bones caused by a want of lime in the soil, but I have found no evidence to support this theory.

Symptoms of paralysis of the hind extremities (paraplegia) appear when the lambs are from one to twelve weeks old, usually at about one month. Lambs of both sexes suffer equally, and are never known to recover. Generally, when in sufficiently good condition, they are taken to the market and sold for whatever they will fetch. The number of lambs affected seems to vary considerably in different parts of Romney Marsh. The usual loss appears to be about 5 per cent, but on some land I have heard of as many as 30 per cent. becoming affected.

In May, 1907, I was able to obtain for examination a number of lambs affected with paralysis of the hind extremities.

In the first lamb, which was about five weeks old, the paralysis was found to be due to pyaemic abscesses in the spinal canal. Several of these abscesses were found, and contained a quantity of slightly greenish coloured pus. Abscesses were also found in the liver of the same lamb. On microscopical examination of the pus, I found that various micro-organisms were present, a short slender bacillus, which showed a tendency to bipolar staining, being the most conspicuous.

In this case, the disease seemed to be quite clearly due to an invasion of the circulation by microbes, which had entered through the unhealed navel. The organisms were carried first to the liver, causing abscesses to form, and then through the general circulation to the membranes of the spinal cord. The case was, in fact, closely allied to navel-ill, which not unfrequently causes considerable trouble in lambs of this age, when no attempt is made at the time of birth to prevent the entrance of micro-organisms into the system through the navel.

From the examination of this lamb, it seemed probable that the so-called "sway-back" was merely a form of "navel-ill," but in all other cases afterwards examined, no abscesses were found in any of the organs.

In all the lambs afterwards examined, no lesions of any description were to be found outside the spinal canal, but in each of these a considerable quantity of clear or slightly flocculent watery fluid was found within the membranes of the spinal cord, and the paralysis of the hind parts seemed to be due to the pressure of the fluid upon the cord. Upon microscopical examination of the spinal fluid, it was found to contain many diplococci. Tubes of beef-broth were inoculated with the fluid, and cultures of the micro-organism were obtained. The diplococci stained well with methylene blue, and did not retain the stain with Gram's method.

Intra-peritoneal inoculations of the culture into guinea-pigs were found to be innocuous. Mice were also found to be immune. The organism was, however, found to be fatal to lambs. A large dose (10 c.c.) of a culture, which had been heated to 60° C. for twenty minutes with the intention of using it as a vaccine for curative treatment, was injected hypodermically into one of the lambs suffering from "sway-back." The lamb was found dead sixteen hours after inoculation. On postmortem examination, a large quantity of clear serum was found in the pleural sacs. Tubes of beef broth were inoculated with the blood of this lamb, and the diplococcus was obtained in pure culture.

In all cases of "sway-back" examined, except the first one mentioned above, a clear or slightly flocculent watery fluid was found in the meninges of the spinal cord. Upon inquiry I found that the shepherds of Romney Marsh had noticed the "water" escaping from the spinal canal when the backbone was severed in the lumbar region. I could not hear, however, that anyone had found matter in the spinal canal. In all cases, the same diplococcus was found microscopically in the spinal fluid, and cultures were obtained in beef-broth. It seemed to me to be probable that this diplococcus was the cause of the disease.

In what way the organism enters the circulation has not yet been proved, but I have formed the theory that the umbilical vein of the unhealed navel is the most probable route.

I have been able to collect some evidence which seems to bear out this theory. While engaged upon the investigation, I was informed by a well-known Kent farmer that he had found a way to prevent lambs from becoming affected with " sway-back." He told me that formerly he had had a good deal of trouble with the disease in lambs born in Romney Marsh, losing year by year about five per cent. from this cause. But he had found that if the in-lamb ewes, a short time before lambing, were removed from Romney Marsh and kept on high ground inland until the lambs were a few weeks old, and the ewes and lambs were then returned to the Marsh, none of the lambs ever became affected. He has adopted this plan now for some years, and has ceased to fear any loss from " sway-back."

From this account, it would seem that all lambs born in the Marsh are liable to become infected, but that lambs born inland do not suffer even if, when only a fortnight old, they are taken to Romney Marsh and placed on land known to cause " sway-back " in lambs born there.

The only conclusion one can draw is, that infection occurs in lambs born in the Marsh during the first fortnight after birth, and that lambs which are kept away from the Marsh during this time are safe from infection.

The most probable mode of infection, during the first few days after birth, is through the unhealed navel. After the navel is firmly healed no possibility of infection by this route is to be feared. One may then infer that if the cause of " sway-back " is, as I suggest, a micro-organism, it will gain entrance to the circulation within a few days after the birth of the lamb, and that it enters through the unhealed navel.

Acting on this theory, I have suggested that " sway-back " may possibly be prevented by a thorough antiseptic treatment of the umbilical cord immediately after the birth of the lamb.

I arranged that a trial of this treatment should be made in Romney Marsh during the recent lambing season. Each lamb treated had its umbilical cord or navel-string tied with tape, which had been soaked in carbolised oil. The remnant of the cord was then painted with Iodized Phenol (a solution of iodine in carbolic acid).

This treatment was adopted with the idea of sealing the blood vessels of the cord, and preventing the entrance of micro-organisms into the circulation.

Unfortunately for the experiment, the flock selected for preventive treatment proved to be singularly free from the disease as only one lamb out of the whole number of treated and untreated animals became affected. So that the results of the trial were quite inconclusive.

I shall be glad if flock owners who have had trouble with this disease, will communicate with me so that I can arrange for more extensive trials of the preventive treatment to be made next spring.

At attempt has also been made to find a method of curative treatment for lambs already affected with " sway-back." A lamb, about three months old, suffering from paralysis of the hind extremities, was selected for treatment.

A culture of the diplococcus, obtained from the spinal fluid of a lamb affected with " sway-back," was heated for fifteen minutes at a temperature of 80° C.

The lamb was given hypodermically an injection of 2 c.c. of the heated culture, and a few days later a second dose of 5 c.c. was given. No ill effect was produced by the injections. Ten weeks later the lamb was found to be fat and well, and was running about freely with scarcely any evidence of the former paralysis. Later the lamb again showed symptoms of paralysis of the hind extremities but whether these were due to some accidental injury or to the original disease, it is impossible to decide. As the lamb was in excellent condition it was sold to the butcher and no post-mortem examination was possible.

It is certain, however, that marked improvement followed the injections of the heated cultures of the diplococcus, but whether such treatment is likely to be of any practical value to the farmer it is not yet possible to say. It is, however, desirable that further experiments should be tried to clearly decide the matter.

I am indebted to Mr. A. Finn and Mr. Alfred Amos for the lambs used in the inquiry, and also to Mr. Bedo Hobbs for carrying out the suggested preventive treatment.

3.—SOME PARASITES OF THE FOURTH STOMACH AND INTESTINES OF SHEEP AND CATTLE.

Parasites of the Fourth Stomach.

During the past ten years much attention has been given to the parasites found in the abomasum of both cattle and sheep.

Although by no means microscopic in size, even the larger of these worms may be easily overlooked in making a post-mortem examination, unless special methods are adopted for the examination of the ingesta, etc. Generally there are only slight evidences of the presence of the parasites to be seen in the coats of the stomach. The mucous membrane may be slightly reddened, and the leaves may be somewhat thicker than normal, but there is very little to attract attention.

Sometimes I have been fortunate enough to see the liquid contents of the stomach, when examined *immediately* after death, strongly agitated by the rapid movements of innumerable worms, although the worms themselves could not be seen.

Occasionally a careful examination of the mucous membrane will discover a few parasites still clinging to it, but soon after death they all loose their hold upon it and mingle with the contents. Whenever possible it is my practice to remove the stomach to the laboratory unopened, and then to adopt the following methods of examination. The coats of the stomach are cut through and the ingesta are turned out into a suitable vessel. The mucous membrane is then washed in gently running water, and examined for the presence of worms, red patches or thickening, or other morbid appearances.

A scraping of the mucous membrane is next examined microscopically with a $\frac{2}{3}$ in. objective. Several parasites may be discovered in the first slide examined.

If no worms are found in this way the ingesta are next examined. After stirring, a small quantity is placed in a flat glass dish, a petrie dish five or six inches in diameter is very useful for this purpose, and a little clean water added to dilute the material if not sufficiently liquid. If a very thin layer is examined over a black surface, with the aid of a pocket lens, the small worms may be seen and removed from the dish on the point of a fine needle.

Or the point of a needle may be drawn through the contents of the dish and washed in clear water after each stroke. In this way it is possible to collect hundreds of worms from the ingesta, in which they are practically invisible, in a very short time.

In the case of the larger worms, such as *Hæmonchus* (*Strongylus*) *contortus*, the contents of the stomach may be placed in a large glass jar, the mouth of which is covered with a piece of muslin securely tied on ; the jar is then placed under a tap and a gentle stream of water is allowed to flow constantly on to the muslin covering. In time the contents of the jar will be washed clean and will be found to consist of innumerable worms mixed with shreds of woody fibre from the food.

It will, I think, be seen that an examination of a suspected stomach in the field will frequently prove insufficient to discover the presence of the parasites.

By adopting the above methods of examination I have been able to demonstrate the presence of enormous numbers of parasites in the fourth stomach of both cattle and sheep.

Parasites found in the Fourth Stomach of Sheep.

Hæmonchus Contortus (*Strongylus Contortus*).

The common round stomach worm frequently occurs in great numbers in the fourth stomach of sheep. It is also found in the stomachs of cattle, but not in sufficient numbers to cause trouble. The parasite is quite common, and occurs widely over Europe and America. As a rule, a few only are found in each sheep, but they may become so numerous that the walls of the abomasum are densely coated with these nematodes, which until mature remain fixed to the walls of the stomach by their heads, their bodies hanging freely into the cavity of the stomach.

Later, when mature or when the host is dead, they relax their hold and fall into the stomach contents.

Description of the Adult Worms.—Colour generally creamy white, but may be pink when adhering to the mucous membrane of the stomach. Length varies slightly when fully matured,* 20 to 30 mm. in the female, 10 to 20 in the male. In form this worm is long, cylindrical, bluntly attenuated towards the head end, acutely so posteriorly in the female, a marked constriction being at the area of the vulva and a further one at the anus, which is nearly apical. The most prominent character is the presence of two marked lateral backwardly projecting pointed papillæ, situated laterally close to the cephalad end. The mouth is unarmed, circular, the surrounding portion being rather swollen, but there are no traces of papillæ. The male is always smaller when full grown than the female. The bursa is tri-lobed, the third lobe being a small prominence attached to the right lobe. The ribs are five in number, the middle and anterior rib furcate, so that there appear to be six ribs. The small third lobe has a single rib which soon bifurcates, the branches being widely divergent. Skin, smooth, but showing transverse striation, and from forty to fifty longitudinal lines. The ovaries are spirally wound around the intestine.

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* 1 in. = 25 millimetres.

The worm may produce fully segmented ova, or it may produce living young, *i.e.*, it may be ovoviviparous. Neither the eggs nor the newly hatched larvæ are dangerous to sheep, as the worms must reach a certain stage before they are able to continue their development when swallowed.

Strongylus Cervicornis (M'Fadyean).

Length, female, 12 to 13 mm., male 8 to 9 mm. Integument with fine transverse striations and longitudinal lines. A fine barb-like papilla directed backwards on each side, about 4 mm. from head. Colour dull to pearly white. The female tapers to each extremity, less so cephalad than caudal; the body is slightly thickened near the vulva, which opens about one sixth of the total length of the body from the caudal extremity. The vulva is prominently protected by a marked flap-like appendage, which is most prominent in the mature female, scarcely perceptible in immature forms.

The male bursa has two prominent lateral fans, each with six prominent rays, the innermost slightly detached from the others, the two median ones are broadest; the middle flap is supported by a single ray which branches at a little more than half its length, and each of these branches bifurcate again, the inner arm being largest and with traces of a secondary branch. The two spiculæ are prominent, yellow in colour, 0.2 to 0.3 mm. long, tapering and slightly curved at their free extremities.

Strongylus cervicornis was also found by me in the fourth stomach of cattle, when it was associated with *Strongylus ostertagi*, and was identified for me by Professor Railliet, of Paris.

Parasites found in the Fourth Stomach of Cattle.

Strongylus Ostertagi (Ostertag).

Length female 6 to 9 mm., male 6 to 7 mm. Integument with very fine transverse striæ. *No* barbed lateral papillæ, as in *cervicornis*. Colour white, often very translucent. The female tapers gradually cephalad, abruptly caudal, very acuminate. Vulva about one seventh of the total length of body from caudal extremity, with a large flap-like hood.

The male bursa differs from that of *S. cervicornis* in having the median lobe rib with the terminal branch larger on the outer than the inner and by the inner ray of the lateral lobes being much broader, the other five rays very similar to *S. cervicornis*. Spiculæ much swollen at the base, the extremities not acuminate but flared out with triplicate appearance. Generally of smaller dimensions than *S. cervicornis*.

Strongylus ostertagi was identified for me by Professor Railliet of Paris. It is thought to be new to this country, and was found by me to be the cause of severe diarrhœa in calves, as described later.

Symptoms.—The symptoms of parasitic disease of the fourth stomach are generally very few and indefinite.

In sheep there is a gradual loss of condition, the animals becoming thin and weak without any other signs of ill-health in the earlier stages, except perhaps an occasional attack of diarrhœa.

In the latter stages a remarkable paleness of the skin and mucous membranes may be seen, after which the animal rapidly becomes so weak that it can only move with great difficulty. The appetite is now entirely lost, œdematous swellings appear about the submaxillary space, throat and dewlap, the wool falls off, leaving large areas of bare skin, the animal becomes incapable of rising, and death soon follows.

In cattle there is the same gradual loss of strength, with extreme emaciation and anæmia, but the diarrhœa may be of a more pronounced character.

In an outbreak which occurred in a number of calves in Sussex, the diarrhæa was constant, and the evacuations were frequently blood-stained. The disease was traced to the presence of enormous numbers of *Strongylus ostertagi* in the fourth stomach, and although a heavy loss had occurred before treatment was begun, yet after the administration of suitable vermifuge remedies all the remaining animals recovered. In other outbreaks in cattle the diarrhœa has been slight and only occurring at long intervals.

On post mortem examination of sheep and cattle an excessive paleness of all the internal organs is seen, while the muscles are pale and watery.

Treatment.—In sheep and lambs the loss from parasitic disease of the fourth stomach may be very heavy unless an early diagnosis is made of the true nature of the disease and suitable treatment is adopted during the early stages of the illness.

Unfortunately, the veterinary surgeon is rarely called in to give advice until a considerable loss had already occurred and the whole remaining flock exhibits symptoms of extreme emaciation and anæmia.

Whenever sheep become emaciated and anæmic before treatment is begun, it is difficult to save them, although with suitable treatment the parasites may be expelled from the stomach. The affected animals die from extreme exhaustion from which they seem to be incapable of rallying, although the cause has been got rid of.

In my experience it is of the greatest importance that the presence of parasites in the abomasum should be recognised early enough to allow of prompt treatment to the whole flock being given while the animals are in a fairly strong condition and before they reach the stage from which they cannot rally.

I have found that cattle seem to have greater powers of recovery, even when in the last stages of the disease, than sheep, and that very few animals need be lost if farmers could be persuaded to call in the veterinary surgeon instead of trusting to the usual packet of quack medicine.

Preventive Treatment.—It is very difficult to get any form of preventive treatment carried out by the farmer. I have, however, occasionally succeeded in persuading one to try the effect of dressing the pasture land with salt and lime during the winter months and keeping sheep off the land during the following summer. The land is also cleaned by being laid down for hay.

I have received most favourable reports from those who have tried these simple measures. Where possible, much benefit would be derived from burning the grass. Unfortunately, much parasitic disease occurs in sheep which are grazed upon the orchards of Kent, where it is impossible to burn the grass, although some success has followed the other measures. It is said to be a great advantage to change the stock on infected pastures, *i.e.*, in place of sheep to put cattle on the land, and *vice versâ.* But, as I have mentioned above, *S. cervicornis* has been found by me in both cattle and sheep, and in all probability the cattle became infested by grazing on land previously occupied by infected sheep.

Although I have not found *S. ostertagi* in sheep, yet in one outbreak in cattle it was reported that the land had previously been occupied by sheep which had suffered from symptoms pointing to the presence of parasites in the fourth stomach.

It must not therefore be assumed that a change of stock will necessarily bring about a cleansing of the pasture as far as these small stomach worms are concerned.

Strongylus Ventricosus.

A small round worm found in the duodenum of cattle, was discovered by me in the duodenum of some Shropshire lambs, which were also infested by *S. cervicornis* in the fourth stomach.

Both stomach and duodenum were inflamed. The lambs suffered from occasional attacks of diarrhœa, anæmia and gradual wasting. They were treated successfully with Lysol, followed by tonics and nutritious dry food.

Description. Body filiform, head small and slightly winged, no buccal papillæ. Integument streaked by fourteen longitudinal ridges, five of the largest being on each of the dorsal and ventral surfaces, and two smaller on each side. Male 6 mm. to 8 mm. in length; caudal pouch wide and obscurely trilobate. Female 11 mm. to 12 mm. long; vulva situated behind the middle of the body, and surrounded by a cutaneous enlargement from which it derives its specific name. This parasite is described by Cooper Courtice as occurring in sheep of the United States of America.

Moniezia Expansa (TÆNIA EXPANSA).

The common broad tapeworm of lambs is the cause of very serious outbreaks of disease, especially in wet seasons and on marsh-lands. It is more frequently met with in sheep than in bovines.

Description. The entire worm measures in length 10ft. to 15ft. but is said to reach a length of 100ft. in cattle (Rudophi). In width it varies from 1–25th of an inch at the head to half or three-quarters of an inch at the tail. The head is unarmed and has four suckers, the neck is very short or lacking. First segments very short, the others longer, are always broader than they are long. The segments gradually increase in width from the head to the end. The worm is easily recognised by its yellow colour. The segments near the end of a mature worm are crammed with eggs or embryos. The ripe segments break off in large sections and are passed from the intestines of the host. The segments retain their vitality for some time after reaching the ground or water. When mature segments are collected from the ground they are so full of eggs that they have become quite round, and resemble in appearance *Amphistoma conicum,* a trematode worm found in the rumen of cattle and sheep. The rate of growth of the broad tapeworm is very rapid. Specimens 6ft. to 10ft. in length may be found in the intestines of lambs only two or three months old.

Life History.—The life history of the *Moniezia expansa* outside the body of the host is at present unknown. From analogy, many have assumed that the parasite runs through two stages, the adult form in the intestines of the lamb or calf, and a larval stage (*Cysticercus*) which will be found in the body of an intermediate host, some small creature, an insect, snail, etc. Some authorities (Cooper Curtice and others) maintain that no intermediate host is required, and consider that development of the embryos may take place in the intestines of the lamb. Curtice, in his work on " The Animal Parasites of Sheep," published by the U.S. Department of Agriculture, describes the embryos, with their three envelopes, from which escape the six-hooked larvæ. He also shows in Plate XV. the young tapeworms consisting of the small heads, each with four suckers, and a short tail-like appendage. He gives his opinion " that these embryos need not pass any of their existence in other invertebrates, although he had not yet been able to produce tapeworm disease by feeding the embryos."

On one occasion I accidentally traced the development of the young tapeworms from the embryos. I had received for examination a number of ripe segments which had been collected from the fæces of infested lambs. The segments were so crammed with eggs that many had assumed the shape of sausages, and were at first mistaken for some species of trematode worm. The segments were placed in a weak solution of glycerine in water, merely for preservation. In a few days a number of minute spherical bodies were seen floating in the liquid. On microscopical examination these were found to be living embryos. These were kept under observation, and ultimately the young tapeworms, having heads with four suckers and short tail-like appendages, were developed.

Unfortunately, no feeding experiments were possible at that time, as it was difficult to obtain lambs not already infested. However, my observations as far as they go confirm the opinion of Cooper Curtice and others that the broad lamb tapeworm can develop from the egg or the embryo to the adult worm without entering the body of an intermediate host. It is, of course, possible that a premature development took place in the embryos I had under observation and that feeding experiments would have failed. I was engaged at the time in a search for the intermediate host, but I saw enough of the development without any intermediate host to cause me to give up my attempts to discover one.

If this view is correct, it will explain the prevalence of tapeworm disease in lambs, and also the large number of parasites which may be found in the intestines of a single individual. It is only necessary to assume that the ewes are the bearers of adult worms, and are constantly spreading the eggs or embryos about the pasture.

When this occurs in wet seasons or on marsh-lands, it would be easy for the lambs while picking and nibbling the blades of grass, as they will do at a very early age, to take the parasites into their mouths and swallow them. The rest of the development of the parasite could then take place in the intestines of the lamb.

As is well known, a lamb when only two or three months old may have in its intestines sufficient tapeworms to fill a pint pot, many of the worms being of such length that it is certain the lamb *must* have been infected very soon after birth. It is also certain that adult sheep may harbour tapeworms and give no evidence of their presence until after slaughter. It is the young animal, under six months old, which is seriously affected by the presence of the worms.

In the marsh-lands of Kent many lambs are seriously infested by tapeworms at the end of May or early in June, while in wet seasons lambs on the chalk downs are also affected.

Symptoms.—One of the earliest signs of tapeworm disease of lambs is seen in the wool, which becomes dry and harsh ; a condition which is easily seen by the experienced flockmaster or shepherd, but which may be overlooked by the untrained observer. Very soon diarrhœa begins, and the lambs then rapidly lose condition, becoming poor, weak, hide-bound and anæmic. Segments of the worms are seen in the fæces, either singly or in considerable sections. Symptoms of colic may occur, and death may take place in lambs which are yet in a fairly strong condition owing to obstruction of the bowel by the large mass of worms, or by an intussusception of the bowel taking place owing to reflex irritation set up by the presence of the worms. Generally, however, death is simply due to sheer exhaustion, brought about by the diarrhœa and the non-assimilation of the food.

Treatment.—It is natural to consider the methods of treatment which bring about the expulsion of the parasites, although it is, in my opinion, equally important to give attention to the food supply.

The parasites come to maturity when about three months old, and large sections of the worms escape from the bowel as the segments ripen. It is believed that the lamb tapeworm does not continue to grow new segments from the original head, but that when all the ripe segments have been expelled, the head itself also escapes. It will thus be seen that the expulsion of the parasites will be brought about naturally in the course of time. It is therefore of the utmost importance that the strength of the host should be maintained by the use of concentrated dry foods given in sufficient and regular quantities. It may be taken as an axiom that the lamb infested with tapeworm cannot support its own body and those of its parasites unless liberal supplies of dry nutritious food are allowed. As I shall try to show in dealing with the preventive treatment, much of the loss due to these parasites can be prevented by giving a liberal diet of dry food as soon as the lambs can be induced to take it.

It is equally important to give dry food during the treatment of infested lambs.

Preventive Treatment.—I have successfully adopted the following method of treatment for lambs living on marsh land which was known to produce tapeworm disease annually.

As soon after birth as was possible the lambs were induced to eat daily from troughs a small amount of dry food. The ewes as well as the lambs were at first allowed access to the troughs, but as soon as the lambs had learned to feed, the troughs were surrounded by hurdles so arranged that only the lambs could pass through them.

When the lambs had been educated to the use of the troughs, the following mixture was added to the dry food already allowed :—

Finely	ground	Linseed Cake	One bushel of each.
,,	,,	Pea Meal	
,,	,,	Common Salt	4 lb. of each.
,,	,,	Aniseed	
,,	,,	Sulphate of Iron	1 lb.

These ingredients were carefully mixed so that the salt and the iron were evenly distributed.

At first only a quarter of a pint of this mixture was allowed for each lamb, afterwards gradually increasing the amount to half a pint daily. This mixture was given regularly day by day to all the lambs, and its use was continued until the autumn.

The lambs evidently derived great benefit from the supplies of dry manger food given at this early age, when they were exposed to the attacks of the parasites.

It is only in very young lambs that any serious loss ever occurs from tapeworm disease ; when lambs are six months old they seem to be able to stand the invasion of the parasites without being seriously affected.

By giving dry nourishing foods as early as possible the lambs are better able to withstand the debilitating effects of the invasion when it occurs.

The salt and the sulphate of iron were at first given as tonics, as it was thought that the administration of these drugs would help to maintain the strength and the vitality of the lambs. Later it was thought that the drugs exerted some vermicidal action, or at any rate prevented the young tapeworms, which have only just gained entrance to the small intestine of the lamb, from fixing their suckers upon the mucous membrane.

I do not wish to suggest that common salt or sulphate of iron would have vermicidal effect on well developed tapeworms, but I do think that the constant presence of these drugs in the alimentary canal of a lamb, which is daily swallowing the immature tapeworms, will be sufficient to deter the worms from attaching themselves to the intestinal mucous membrane and so gaining a lodgment in the bowel.

I have seen the most excellent results follow this treatment, and I suggest that in this way it is possible for lambs to escape infection altogether or to be saved from any extensive invasion.

If this treatment is adopted it must be begun early, in fact as soon as the lambs can be induced to eat dry food.

It is no use waiting until the intestines of the lambs are crowded with parasites, and the animals are already weakened by diarrhœa and the inability to digest their food. With this simple preventive treatment I believe that much of the mortality due to tapeworm disease may be prevented.

Suggestions have been made to farmers from time to time that infested pastures might be improved by top dressings of common salt, nitrate of soda, gas lime, etc., but I have as yet had no opportunity of noting the effect of such treatment.

Sclerostoma Hypostomum.

S. Hypostomum is found in the large intestines of ruminants. The parasite is said to be of rare occurrence. I have, however, met with it in a flock of Southdown lambs, 200 in number, the whole of which were destroyed by the ravages of the parasite in the space of two months.

Description.—Body white, filiform, cylindrical, and rigid. Head globular, slightly curved and oliquely truncated towards the ventral surface; mouth furnished with a row of narrow, sharp, sawlike teeth, and surrounded by six papillæ. Male, 16 mm. long; caudal pouch short, obliquely cut and campanuliform. Female, 24 mm. long; tail often encrusted with a dark yellow substance, and terminating in a sharp point curving upwards; vulva situated a little in front of the anus.

Symptoms.—The lambs suffered from severe diarrhœa, debility and wasting.

On *post mortem* examination large numbers of the worms were discovered in the colon, the contents of which were stained the colour of chocolate. The mucous membrane of the colon was covered with minute punctiform hæmorrhagic spots.

This parasite of the sheep belongs to the same family as the *Sclerostoma tetracanthum* and *Sclerostoma equinum* which are known to encyst themselves in the larval stage in the walls of the cæcum and colon. No tumours were, however, discovered in the colon of the lamb.

As the few remaining lambs were, at the time of my visit, in an apparently hopeless condition, the owner declined to attempt any treatment.

SOIL BACTERIOLOGY.

By C. T. Gimingham, A.I.C.

It is only within about the last twenty years that the extreme significance and importance of micro-organisms in the domain of agriculture have been realised, and the study of agricultural bacteriology, both in its theoretical and practical aspects, is of the most recent growth.

The numerous and complicated changes which are continually taking place in the soil have been made the subject of special study of late years and it is becoming increasingly evident that many of the most important problems in connection with fertility are to be solved with the aid of bacteriology. Already much has been done by soil-bacteriological research, particularly in Germany and America, in spite of the short time during which accurate methods have been at the disposal of workers. It is, however, inevitable in such a vast and complicated field of work, and one of such very recent development, that a great number of questions should still remain unsettled.

Most of the earlier investigators confined their attention to the changes resulting from the actions of particular species of bacteria, but we shall need to acquire a more general knowledge of the working of bacteria in the soil before we can arrive at definite conclusions as to what exactly constitutes the bacteriological factor in soil fertility. At all events, it is certain that various species are intimately connected with the breaking down of organic material in the soil. The simpler compounds which are thus produced can serve as plant foods, so that the maintenance of the soil in a condition of fertility is largely dependent on the activities of these bacteria. Destroy the micro-organisms in a sample of soil by sterilisation and almost all changes cease ; no humus is formed from the decay of organic matter, no nitrification takes place and there is no fixation of nitrogen.

Especially are these minute organisms concerned in the question of the supply of nitrogen to the plant. All organic nitrogenous material finding its way into the soil in a short time is decomposed, much of the nitrogen eventually becoming ammonia. In particular cases there may be a loss of nitrogen, split off as the free element. This decomposition is brought about by many kinds of bacteria, but little is known with regard to the particular changes due to any one species.

However, ammonia is not a usually available form of nitrogen, and must be converted to nitric acid before the plant can make use of it. As is well known, the production of nitrates in the soil, or " nitrification " is also a biological process. Through the researches of Schloesing and Muntz, of Warington and of Winogradski, we now know that two species of bacteria are concerned in this oxidation of ammonia to nitric acid. These organisms are unique, in that they are able to live on purely inorganic media, obtaining their supply of carbon from the carbon dioxide of the atmosphere. The isolation and pure culture of these two species has been, perhaps, one of the greatest successes hitherto obtained in agricultural bacteriology. In order to make use most profitably of those various organisms, the farmer needs to know what are the conditions which result in the most vigorous production of ammonia and its subsequent rapid nitrification. At the same time he must aim at reducing to a minimum the loss due to the splitting off of free nitrogen.

Twenty-five years ago scientists were very much puzzled to account for the behaviour of leguminous crops, such as peas, beans or clover, on the then-accepted theory of the non-fixation of atmospheric nitrogen by plants. After a great deal of work had been done on the subject by many investigators, the problem was finally solved by Hellriegel and Wilfarth in 1886, and here again bacteria were found to be intimately concerned. It was clearly demonstrated that, with the help of the bacteria living in the nodules on their roots, plants belonging to the order leguminosæ are able to obtain their supply of nitrogen from the atmosphere. This conclusion has since been confirmed by many other workers. The actual means by which the assimilation of the nitrogen is effected, and the processes involved, are still subjects of research and discussion.

In this connection, the practical problem of the inoculation of soil with cultures of these nodule bacteria, in order to benefit leguminous crops, is much to the fore. A number of commercial preparations for this purpose have been placed on the market. The first of these, known as " Nitragin," was of German origin, and consisted essentially of a pure culture of the organisms in nutrient gelatine,—a nitrogen-containing medium. Many field trials were carried out with it, both in Europe and America, but with somewhat unsatisfactory results on the whole. However, there were a sufficient number of successes obtained to encourage the belief that the method was practicable. Then, in 1903, Moore, in the United States, introduced cultures grown in a fluid medium, from which all combined nitrogen was excluded, with the idea of thus stimulating the bacteria to a more active fixation of atmospheric nitrogen. Several modifications of Moore's original method have been tried, and the experiments have, in many cases, been extremely successful. Trials carried out on very poor or reclaimed land have shown that it is on soils of this kind that the application of pure cultures of the nodule organism to leguminous crops is likely to be of most value. It cannot, however, yet be said that the practical use of such cultures is always to be relied on.

The most recent of these commercial preparations is Prof. Bottomley's " Nitrobacterine," which has been extensively advertised in this country during the last year. On the College farm experiments are in progress with this material, both on a mixture of " seeds " sown under barley, and on peas and beans.

Apart from such symbiotic fixation of nitrogen, there have been discovered in the last six or eight years, certain bacteria with the power of assimilating the nitrogen of the atmosphere whilst living, so far as we know, free and unattached in the soil. They are to be found in nearly all types of soil ; they obtain the energy necessary for the fixing of free nitrogen by the oxidation of carbohydrates. How great is the importance of this class of organism is still uncertain, and our knowledge with regard to them is scanty ; what are the soil conditions most favourable to the fixation of nitrogen by them, whether they work more effectively in association with certain other organisms, what may be the possibility of artificially increasing their nitrogen-fixing power and many other points, all remain to be worked out.

It is with the object of carrying out work regarding problems of this kind that a laboratory has this year been equipped at the College, and work on soil bacteriology has already begun. It will now be possible to undertake the investigation of problems connected with the bacteria of the soil and possibly interesting features of local soils, etc., may be brought to light.

REPORT FROM THE
CHEMICAL RESEARCH LABORATORY,
1902-1907.

By Edward J. Russell, D.Sc. (Lond.), late Head of the Chemical
Department, now "Goldsmith" Soil Chemist,
Rothamsted Experiment Station.

Introduction.

During the writer's term of office as Head of the Chemical Department a number of problems arising out of the agriculture of Kent and Surrey came under notice ; some involved simply the application of well established principles, and required but little experimental work by way of verification, others were more complex, and required a systematic investigation. The former problems, when of sufficiently general interest, were dealt with in the annual Reports from the Analytical Laboratory or or else in the technical press, and are not discussed here ; the latter have usually been published in various scientific or agricultural journals, and it has been thought advisable to collect the results as a separate report.

The very wide scope of the agriculture of Kent and Surrey necessitated a corresponding variety in the problems dealt with in the Research Laboratory. Probably no two counties in the British Isles present a greater variety of agricultural practices ; some of the best and most intense farming possible is seen on the Brick earths and the Hythe and Thanet beds, where many acres of hops are tended with as much care as is bestowed on any flower garden, whilst, on the other hand, a widely different type of farming prevails on the thin chalk soils of the North Downs and on the sands of Surrey. The proximity of London makes dairy farming of primary importance in many districts. In other places, sheep, and elsewhere fruit, are of chief importance, whilst scattered about in the counties are small holders depending on poultry, vegetable production, etc. Each type of farming involves a distinct set of problems, and now that the low margin of profit necessitates the strictest economy, it is more than ever important that the farmer should have access to some institution where his problems can be investigated as they arise so that he may be put in possession of information which will enable him to modify his practice if he thinks fit.

It is unnecessary at the present time, and in Kent and Surrey, to lay stress on the fact that problems in agriculture can only be solved by first investigating the principles involved ; this method, indirect though it often appears to the layman, can alone be relied upon to furnish results of permanent value. The older way of tentative trials and efforts to solve the problem without any reference to the principles involved has in the past led to many advances in agricultural practice, but it only gives results by accident, often at great expense, and without the collateral information necessary to apply them to other cases ; it is only necessary in proof to study the early history of drainage in England. Just as a watchmaker's skill in finding out what is wrong with a watch depends on his knowledge of its mechanism, so the agricultural chemist's power of solving a soil problem is strictly limited by his knowledge of what is going on in the soil. Some of the work referred to in this Report was intended simply to furnish information about soil processes, and has as yet no direct practical application. This will come later when more complete knowledge has been gained.

Investigations on the Soil.

The soil investigations carried out have all been connected with fertility, and especially with the relation between the productiveness of the soil and the plant food present therein. It is well known that not all of the plant food in the soil is available to the plant. Large quantities appear in the ordinary course of things never to be drawn upon at all, thus the poorest and most exhausted soils we have been able to find in Kent and Surrey contain about .09 per cent. of nitrogen, well over 2,000 lbs. per acre in the top nine inches, while a five-quarter wheat crop would only take out about 60 lbs. Yet this 2,000 lbs. of nitrogen is so locked up that it is necessary, in order to produce crops at all, to add 50 lbs. or more in manure at a somewhat considerable cost. One of the problems investigated has been the production of available plant food in the soil.

It is now well recognised that non-leguminous crops take up their nitrogen in the form of nitrates, though apparently they can also, when necessary, take up ammonia as well. The nitrogen compounds present in the soil and those supplied in dung, guano, rapecake, and other organic manures are very complex, and are not themselves useful to plants, but they are in part broken down to ammonia, and then converted to nitrates, by the living organisms of the soil. In the preliminary stages, earth worms, etc., no doubt play an important part, but the chief decomposition is brought about by the minute organisms which are so numerous in soils that a salt spoonful of a hop garden soil will contain some ten millions of them. The activity of these organisms is, therefore, a very important factor in determining the productiveness of the soil, since it regulates the rate at which the necessary plant foods, ammonia and nitrates, will be formed.

An accidental observation led up to a method of working which has turned out very useful. Some experiments had been going on in the laboratory to study the rate at which phosphorus absorbs oxygen at ordinary temperature, and out of curiosity certain soils were examined in the same way. It was found that an infertile soil absorbed only little oxygen, whilst a rich garden soil absorbed a good deal ; and a systematic examination of a number of soils of known agricultural history showed that the rates of oxidation were in the same order as the productiveness. Thus the following results were obtained for some of the Woburn soils :—

				ANALYTICAL DATA.			
	HISTORY.	Order of productiveness.	Oxygen absorbed in 17 days. (m.m.)	Nitrogen.	Carbon.	Loss on Ignition.	Calcium Carbonate.
Stiff Oxford clay	Wheat stubble -	1	23.2	.252	2.53	8.73	.021
Road piece	Wheat stubble preceded by mangolds fed on land	2	18.7	.172	1.76	5.31	.072
Lansome field	Barley following mustard ploughed in ; mineral manure	3	14.1	.122	1.19	4.17	.027
Lansome field	Barley following tares ploughed in ; mineral manure	4	10.2	.132	1.24	3.22	.051
Lansome field	Barley following tares ploughed in ; no mineral manure	5	8.2	.109	1.18	3.46	.008
Stackyard field	Wheat unmanured -	6	8.2	.060	1.39	4.07	.004
Stackyard field	Wheat, ammonium salts only - - - - -	7	7.8	.102	1.29	4.58	nil.

The amount of oxygen absorbed shows no simple relation to the analytical data, although the percentages of nitrogen and of calcium carbonate are, with two or three exceptions, pretty well in line with it. It clearly does not depend entirely on the amount of organic matter present whether this is estimated from the percentage of carbon or the loss on ignition. Other experiments showed that the absorption is brought about by micro organisms; it is increased by all processes favourable to them—by the addition of water, and of calcium carbonate, and by rise of temperature, and it is greatly reduced when they are killed by heating to about 120°. As a working hypothesis it was assumed that the absorption of oxygen affords a measure of the total activity of the soil organisms, so that where a large amount of oxygen is taken up the organisms are supposed to be very active, decomposition is hastened, and plant food is produced at a more rapid rate than in a soil where a smaller absorption of oxygen indicates less activity on the part of the organisms.

Another accidental observation led to further developments. In sterilising some soil the temperature on one occasion rose to 100° only, so that the spores were not killed, and instead of the rate of oxidation decreasing, it showed a marked increase. Other methods of partially sterilising soil were then tried: volatile substances like carbon disulphide, chloroform, and toluene were poured in, left to act a few days, and then allowed to volatilise; in each case there was a distinct increase in the amount of oxygen absorbed, indicating an increased bacterial activity. The following are some out of many results showing the amounts of oxygen absorbed by variously treated soils:—

				TREATED WITH		
	Untreated.	Heated.	Untreated.	Carbon Disulphide.	Toluene.	Chloroform.
Oxygen absorbed -	100	215	100	151	157	118

Pot experiments showed that this treatment also increased the amount of plant food in the soil; the crops being larger and containing a higher percentage of plant food. Thus the data contained in the Table on p. 432 were obtained for mustard grown in heated and unheated soil respectively, and for buckwheat in soils treated with various antiseptics.

The effect of one treatment lasted into a second, and sometimes into a third crop. These experiments were carried out with a fertile hop garden soil, but similar results have also been obtained with a poor soil. The important point is that there is a large increase in the amount of plant food "available" for the plant, after the soil has been partially sterilised. It appears that there are at least two factors involved. For some reason, not yet understood, partial

	MUSTARD.		BUCKWHEAT.			
				SOIL TREATED WITH		
	Untreated Soil.	Heated Soil.	Untreated Soil.	Carbon Disulphide.	Toluene.	Chloroform.
Weight of dry matter produced, gms. - -	15.88	24.33	18.14	23.27	20.98	25.08
Percentage of nitrogen in dry matter - -	2.30	4.43	2.75	3.15	3.00	2.91
Weight of nitrogen taken by crop, gms. - -	.37	1.08	.50	.73	.63	.73
Percentage of phosphoric acid in dry matter -	1.00	2.08	1.87	2.34	2.12	2.45
Weight of phosphoric acid taken by crop, gms. -	.16	.51	.34	.54	.45	.61
Percentage of potash in dry matter - - -	4.20	5.02	5.62	5.97	5.79	5.65
Weight of potash taken by crop, gms. - -	.67	1.22	1.02	1.39	1.21	1.41

sterilisation has the effect of increasing, after a time, the total bacterial activity, so that plant food is now produced in greater quantity from the more complex substances present in the soil. This is also in accordance with the observed increase in the amount of oxygen absorbed. There is also reason to suppose that partial sterilisation kills a number of organisms which, without benefiting the plant, compete with it for whatever food happens to be present in the soil: on their removal a larger amount of food is left available for the plant. In the case of the heated soils there is an undoubted chemical decomposition as well.

All these questions are under further investigation, and the results will, it is hoped, materially increase our knowledge of the processes by which plant food is made in the soil. No immediate practical applications are suggested ; for the present it is sufficient to study the principles involved and trace the course of the change.

Another problem arising during the course of this work has been dealt with. It is well known that the oxidation of one body may facilitate the oxidation of another in contact with it, the process being known as autoxidation. Experiments were made to ascertain whether the oxidation of soil constituents going on under field conditions would facilitate the oxidation of nitrogen or ammonia, and lead to a non-bacterial production of nitrates. At the same time experiments were carried out to see whether nitrites or nitrates could be formed by any chemical or physical processes known to go on in the soil. The results were all negative, and indicate that the production of nitrates in the soil is entirely bacterial.

Numerous observations on fertility have been made in connection with the soil survey, and the general advisory work of the department, but as these will be embodied in the soil report about to be issued they need not be dealt with here. Fertility has been found to depend on numerous factors including the composition of the soil, the nature of the subsoil, the water supply, and the topographical position. Thus some of the very productive soils of East Kent were found to owe part, at any rate, of their productiveness to the fact that they lay towards the bottom of a slope, and received from the higher ground a regular drift of underground water containing a fair proportion of dissolved matter. On the other hand, land lying at the bottom of a slope suffers from certain temperature disadvantages ; it is hotter by day, but colder by night, and is, therefore, more liable to frost in late spring and early autumn than land lying higher up.

Publications.

1. Oxidation in Soils and its Connection with Fertility. Part I. E. J. R. *Journal of Agricultural Science*, 1905. Vol. 1. p. 261.
2. Part II. The Influence of Partial Sterilisation. F. V. Darbishire and E.J.R. *Ibid*, 1907. Vol. 2. p. 305.
3. On the Question whether Nitrates or Nitrites are produced by Non-bacterial Processes in the Soil. Norman Smith and E. J. R. *Ibid*, 1906. Vol. 1. p. 444.
4. —Some Air-temperature Readings on Several Stations on Sloping Ground. R. S. Vinson and E. J. R. *Ibid*. 1970. Vol. 2. p. 221.
5. The Relation between the Geographical Position and the Productive Capacity of Land. E. J. R. *Journal of the Manchester Geographical Society*, 1907. p. 28.

Investigations on Maize and Maize Silage.

The chalk soils of Kent and Surrey are pre-eminently adapted to sheep, and in consequence large quantities of roots are necessary to provide keep throughout the winter. Unfortunately, however, these soils are not very well adapted to swedes; they lack the necessary supply of water to produce a full crop, and they are very liable to "flea," especially in dry seasons, so that an interval of four or five years has to elapse between successive crops on the same ground, *i.e.*, a five or six course rotation has to be adopted. Mangolds fare little better; being deeper rooted they are less dependent than swedes on the summer rainfall, but still they do not on these soils yield large crops.

In America, where root crops are found to be expensive because of the scarcity of labour, their place is taken by green maize and silage; experiments were, therefore, undertaken to see if a similar practice could be adopted here. It was ascertained by the agricultural staff that from fifteen to thirty tons per acre (according to season) of green maize could be produced without difficulty on our chalky soil, and further, that the seed need not be sown till June, so that it can be put on to land where swedes or mangolds have failed. Analysis showed that the green crop somewhat resembled grass in composition, especially in a warm, dry season, but it contained only half as much nitrogen and mineral matter.

The average composition of green maize cut at the end of September, or early in October, was found to be as follows:—

	Dry matter.	Ether Extract. 1	Total Nitrogen × 6·25. 2	Nitrogen Free Extract. 3	Fibre.	Mineral Matter.
MAIZE Good seasons (1901 and 1905) -	20.3	.68	1.97	11·75	4.78	1.14
Bad season (1903) -	13.35	.16	1.81	6.70	3.83	.79
Average of all (1901 to 1906) - -	16.8	.48	1.78	9.33	4.21	1.0
GRASS - - -	23.3	.9	4.0	10.9	5.2	2.3

1 Often called oil, but not actually oil in this case. 2 Often called protein, but partly consists of non-protein material. 3 Often called Carbohydrate.

In cold, wet seasons the dry matter falls to a little over 13 per cent., the difference showing itself mainly in the very nutritious nitrogen-free extract group (often, but in this case erroneously, called carbohydrates), and this change in composition is accompanied by a marked fall in the crop, so that the total amount of food stuff produced per acre is much reduced. But in warm, dry seasons maize can be relied upon to furnish nutritious and succulent keep in September and early October at a cost which is distinctly less than that of roots.

However, maize can only take an important place in the economy of the farm if it can be converted into good and cheap silage, and the comparison must be made between roots and silage, and not between roots and maize. In order to study this question, the silage made for several consecutive years in a large stave silo on the farm was examined in the laboratory and experiments were made to discover the factors concerned in its production. The composition was found to be very fairly constant, and showed much less fluctuation than that of the original maize; the average results for the six seasons, 1902-1907, are given below :—

	Dry Matter.	Ether Extract	Total Nitrogen ×6·25.	True Protein.	Nitrogen Free Extract.	Sugar.	Fibre.	Mineral Matter.
Silage (average 1902-1907) -	13	.4	1.45	.87	5.4	nil.	4.8	1.0
Swedes - - - -	10.7	.2	1.4	.7	7.2	6.0	1.1	.8
Mangolds - - -	12.5	.1	1.1	.4	9.6	7.5	.8	.9

It will be noticed that silage differs in at least two important respects from roots; it contains a large amount of fibre, and no sugar, so that its nutritive value is distinctly lower. A large number of substances of little or no feeding value are present, including the volatile fatty acids, formic, acetic, butyric, isopropyl-acetic, and hexoic acids to which the smell of silage is due, and also lactic, malic and succinic acids. It was also found that the nitrogen compounds consist partly of bodies far simpler and less useful than the proteins — the mono- and diamino- acids, the the latter including histidine, lysin, and ornithin, the purin bases, adenin, and at least one other, besides pentamethylene diamine and possibly other amines. Most of these do not occur in maize, or are found in much smaller amount, hence there has been a deterioration in the silo.

There is also a considerable loss of substance. Numerous attempts have been made to determine the amount of loss ; weighed bags of maize were buried in the silo at the time of filling, and then when the silo was being emptied they were weighed as they were recovered, their contents analysed, and the results compared with those obtained from the analysis of the maize originally put in. No two bags give the same results ; the loss is apparently not uniform throughout the silo, and there is a tendency for some of the acids and the soluble mineral matter to wash downwards ; but the average of all the experiments shows the general distribution of the loss.

MEAN LOSSES IN THE SILO, 1904 & 1905.

	Dry Matter.	Ether Extract.	Total Nitrogen.	Protein Nitrogen.	Non-Protein Nitrogen.	Nitrogen Free Extract.	Fibre.	Furfurol.
Put in	100	100	100	100	100	100	100	100
Brought out	64	84	74	45	183	45	92	68
Loss	36	16	26	55		55	8	32
Gain					83			

The fibre is practically unaltered during the process ; this result was confirmed by microscopic examination, and shows that coarse poor herbage is not improved by ensiling. The nitrogen free extract suffers most loss ; the sugar entirely disappears, and so also do some of the less resistant celluloses, as shown by the fall in the furfurol figure. There is a large drop in the amount of protein, but the new non-protein compounds formed have a certain feeding value so that the loss is not as great as it appears. The loss of nitrogen may be caused by volatilisation of ammonia. The total loss of dry matter has varied rather, but on the average is 36 per cent., while in America the average loss is said to be only about 20 per cent. ; it is probable that with a better silo and better management the average loss would come below 36 per cent., but there is no reason to suppose that we could improve on the American result, because at the time of cutting our maize is neither as mature nor as rich in dry matter as theirs.

Further, an investigation of the mechanism of the change showed that the deterioration above referred to would still take place, even if the loss of dry matter was reduced, for it is an essential part of the process of ensilage. This question is fully dealt with in the paper in the *Journal of Agricultural Science* (1908), it will suffice here to give the general conclusions arrived at.

When the maize is cut up and put into the silo the cells are still alive, and their vital functions continue. Respiration goes on, and sugar, etc., is used up, but in absence of air oxidation is not complete, and intermediate bodies, alcohol, acetic acid, butyric and other acids are formed in addition to carbon dioxide and water. The tryptic enzymes of the cell act on the protein, forming the usual hydrolytic products, amino-acids, diamino-acids, etc. From the nucleo-proteins purin bases are produced in addition. The heat developed during these processes cannot be dissipated by the evaporation of water, as it usually is in the living plant, because water vapour cannot escape from the silo ; instead it raises the temperature of the mass. The increased temperature reacts on the rate of respiration and accelerates it, but, as no more material is being elaborated, and only decomposition is taking place, the process soon comes to an end, and the cell dies for want of more substance to break down ; it loses its turgidity, becomes flaccid, and the mass settles down ; the temperature also steadily falls.* The decomposition of the protein has also been accelerated by the rise in temperature, but is not necessarily stopped by the death of the cell, because the enzymes when once formed are not dependent on the life of the cell ; in other words, it is an autolytic decomposition. Some of the products formed in the above changes inhibit the development of mould, and the general conditions obtaining in the silo are unfavourable to putrefaction. The mass therefore remains good for food for a long time.

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* The maximum of 33° to 37°C. observed in the Wye silo was always reached in about five days ; there was then a slow but regular fall.

It is, however, not sterile. Certain bacteria are always present and attack the softer celluloses (but not to any extent the resistant "fibre"), producing the humus, some of the fatty acids, and probably the succinic acid present in silage. They also carry several stages further the decomposition of certain of the nitrogen compounds, and produce those bodies which cannot be supposed to arise from tryptic hydrolysis of protein. Thus pentamethylene diamine is a well known decomposition product of lysin; ornithin is known to arise from arginin, and the absence of the latter body may be due to its decomposition into ornithin and urea, which would further change into ammonium carbonate.

In the table on p. 439 are set out the changes as the author supposes them to take place. The lactic and malic acids might have arisen from the amino-acids or from the carbohydrate material; the present experiments do not enable one to decide this point.

GENERAL CONCLUSIONS.

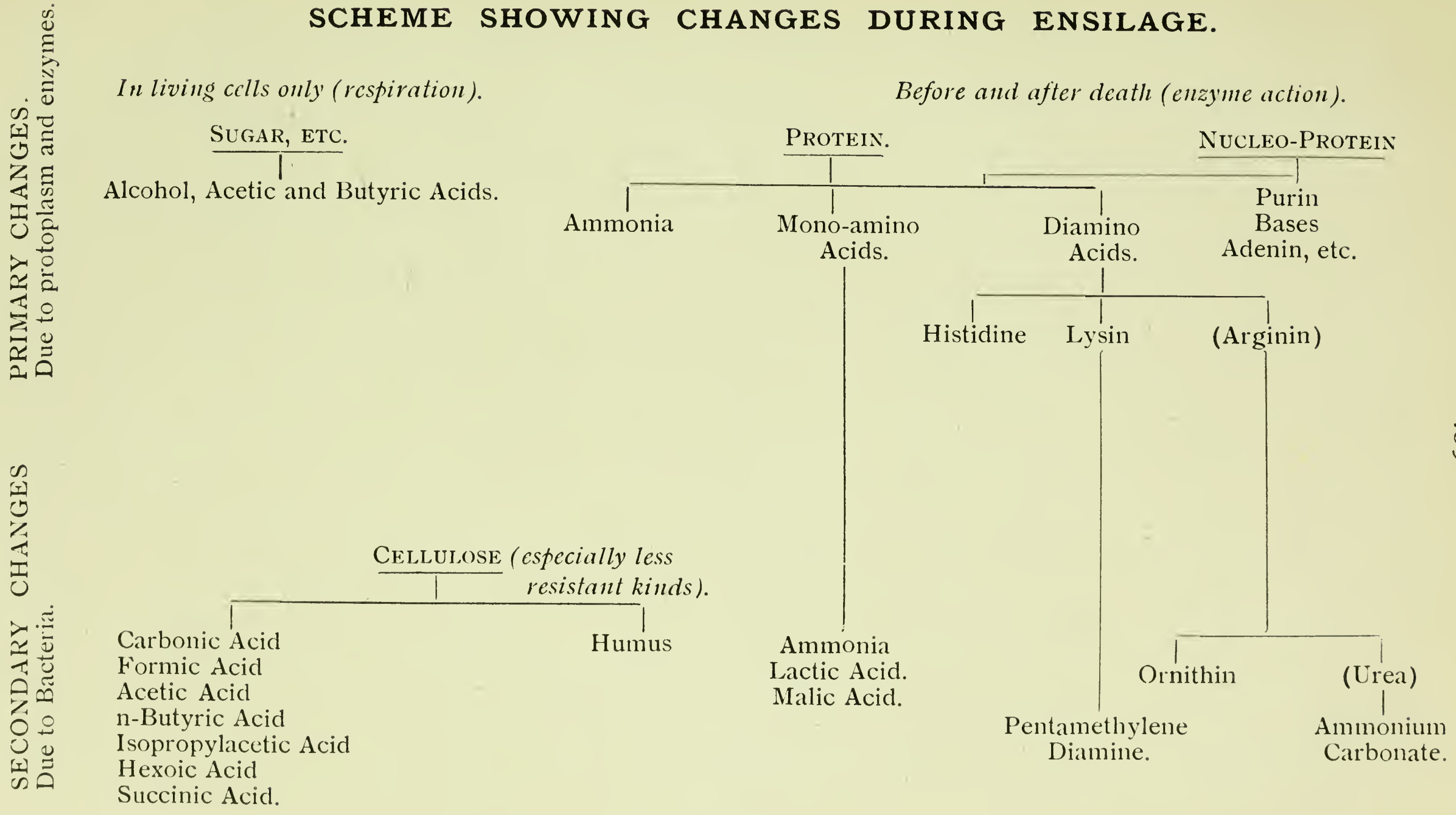
1. The main groups of compounds found in maize silage are fatty acids, hydroxy-acids, amino-acids, basic diamino-acids, purin bases, and other bases besides the ordinary constituents of the plant cell—the celluloses, protein, etc. The non-nitrogenous acids are not found in maize at the time of cutting, and the nitrogenous acids, though they are found, only occur to a smaller extent than in silage.

2. The characteristic silage changes are the disappearance of sugar, of some less resistant celluloses, and of part of the protein, and the formation of the bodies enumerated above.

3. Three agents appear to be involved in making silage, the living maize cell, the enzymes, and micro-organisms. It is considered that the two former bring about the primary and essential changes, the latter only secondary and non-essential changes.

4. The formation of acetic and butyric acids appears to be a respiration effect, and comes about when the living cell is deprived of oxygen. Sugar disappears during the process. The decomposition of the protein and nucleo-protein is effected by enzymes

SCHEME SHOWING CHANGES DURING ENSILAGE.



The compounds in brackets were not found in silage, but are supposed to have been formed as intermediate products.

present at the time of cutting the maize, which can go on acting in the silo even after the cell is dead. Characteristic proteolytic products were identified in the silage. These are regarded as the primary and essential changes.

5. Bacteria are, however, always present, and attack the less resistant celluloses, the products of proteolysis, and other substances as well, but not the resistant fibre. Typical products of bacterial activity were found—formic acid, higher fatty acids, humus, and amines.

6. The growth of mould is quite inhibited, except at the surface layer, where air gets in. Here the changes are fundamentally different; there is no development of acetic or butyric acids, the mass is alkaline, non-protein material already existing in the maize is converted into protein, and there is also a loss of nitrogen.

PRACTICAL CONCLUSIONS.

1. Large crops of maize can be produced in Kent and Surrey (and in other counties as well, including parts of Cheshire and of Norfolk) in less time than is required by any other crop.

2. The composition somewhat resembles that of grass; it depends on the season, and is least satisfactory in cold, wet seasons when the crop is small, and most satisfactory in hot, dry ones when the crop is large.

3. All classes of stock take to maize, and it is well worth a trial where succulent fodder is wanted during September.

4. Maize can be converted into silage, which is quite a useful food, though inferior to swedes and mangolds. In the process of manufacture there is a certain deterioration and a loss of dry matter found to vary between 30 and 40 per cent., and to fall mainly on the valuable nitrogen free extract and protein, and least on the worthless fibre. The loss might be reduced in a better silo, but the deterioration cannot be avoided. It hardly appears worth while growing maize for the production of silage except where mangolds are unusually costly.

PUBLICATIONS.

1. On Maize Silage. H. F. J. Clements and E. J. R. *Journal of the South Eastern Agricultural College*, 1904, No. 13, p. 18.

2. Maize as a Fodder and Silage Crop. E. J. R. *Journal of the Board of Agriculture,* 1907, Vol. XIV., p. 14.

3. The Composition of Green Maize and of the Silage Produced therefrom. H. E. Annett and E. J. R. *Journal of Agricultural Science,* 1908, Vol. 2. p. 382.

4. The Chemical Changes taking place during the Ensilage of Maize. E. J. R. *Ibidem,* 1908, Vol. 2. p. 392.

Investigations on Farmyard Manure.

The high farming of Kent requires large quantities of dung, more, indeed, than can be made on the farm, so that stable manure has to be purchased from town. It is not an uncommon practice for the hop grower to fatten bullocks largely for the sake of their dung, as the wheat producer used to do in the days of high prices; the practice is expensive, but it certainly provides good manure.

Three problems have been investigated in the laboratory: (1) the amount of unavoidable loss in making dung; (2) whether a high grade linseed cake (*i.e.,* one rich in oil) gives better dung than one poor in oil; (3) the relative values of straw and peat moss, and of straw and fern, for litter.

The first two were dealt with in the same experiment. Two red polled bullocks were kept for twelve weeks in separate adjoining covered boxes of approximately the same size, supplied with the same amount of litter, and fed with weighed quantities of food, which had been analysed. The dung remained under the animals the whole time and was well trodden, and at the end of the experiment it was weighed and analysed. Each animal received daily 18lbs. of linseed cake, 40 lbs. of swedes and 16 lbs. of hay; in one case the cake contained 7 per cent. of oil and 37 per cent. of protein, in the other it contained 12 per cent. oil and 25 per cent. of protein. The amounts of digestible and of indigestible nitrogen supplied during the whole period were:—

	Digestible Nitrogen. lbs.	Indigestible Nitrogen. lbs.	Total Nitrogen. lbs.
No. 1 (on poor cake)	43.8	11.8	55.6
No. 2 (on rich cake)	33.2	10.2	43.4

The indigestible nitrogen compounds have resisted the attack of the digestive juices in the animal's body, and are probably not easily decomposed in the soil, so that they are only slowly available as plant food ; the digestible compounds, on the other hand, are taken up by the animal, about 5 per cent. of the nitrogen is retained in the flesh laid on, and the rest is excreted by the urine, forming highly available plant food. If no changes took place the quickly available nitrogen in the dung should equal the digestible nitrogen in the food minus the amount kept in the body, whilst the slowly available nitrogen in the dung should be the sum of the indigestible nitrogen of the food and the nitrogen of the litter. The following table shows that this is not the case, and considerable change has evidently gone on.

AMOUNTS OF NITROGEN IN DUNG.

	QUICKLY AVAILABLE.		SLOWLY AVAILABLE.		TOTAL.	
	No. 1. lbs.	No. 2. lbs.	No. 1. lbs.	No. 2. lbs.	No. 1. lbs.	No. 2. lbs.
Expected - - -	40.8	31.1	16.5	14.8	56.9	45.7
Found - - - -	28.6	22.1	20.9	16.9	49.5	39.0
Loss in lbs. - - -	12.1	9.0			7.4	6.7
Percentage loss - -	**29.8**	**29.0**			**14.9**	**14.4**
Gain in lbs. - - -			4.4	2.1		
Percentage gain - -			**21.1**	**12.5**		

There has been a loss of 30 per cent. of the "quickly available" nitrogen, but some of this has been changed into "slowly available" compounds, so that the net absolute loss is only 15 per cent. The loss of dry matter is, however, much greater and lies between 50 and 60 per cent., so that the carbon, hydrogen, and oxygen obviously suffer much more than does the nitrogen.

It is a matter of serious practical importance that, notwithstanding the care taken in making the dung, there has been a loss of about 15 per cent. of the total nitrogen ; this agrees so closely with the results of other investigators, that one can only suppose it to be an inevitable part of the process no matter how good the management. The loss falls entirely on the quickly available, *i.e.*, the most useful, nitrogen compounds, as indeed might be expected from their tendency to form ammonia which volatilises and is lost. The gain in the slowly available and less useful compounds may be attributed to the activity of micro-organisms in consuming the quickly available compounds as food and building them up into cell constituents. The total loss in value suffered by the dung cannot be precisely stated, and is no doubt less than the 30 per cent. loss of quickly available nitrogen, since some of the slowly available compounds produced may be reconverted in the soil to soluble forms. But these reconversions are well known to involve waste ; the loss is certainly more than the 15 per cent. loss of total nitrogen, and unfortunately we cannot suggest any way of preventing it.

These experiments only deal with the loss in making dung. On storing, a further loss takes place, so that if the dung is drawn up into a mixen, the loss may become considerable. The most certain way of getting the full manurial value of the food is to feed it on the land ; the next best is to cart the dung straight from the yard on to the land ; while a mixen involves waste, especially if short dung is made. Unfortunately folding is not always practicable, and mixens have to be made ; in this case the cart must be drawn over them to make the mass as compact as possible, so as to keep the loss as low as can be. No one has yet succeeded in preventing loss, and there is no evidence to show that anything can be sprinkled in with the heap to reduce loss.

Turning now to the second problem, the question whether a high grade linseed cake produces better dung than one poor in oil, we find that per ton of linseed cake consumed the poor one gives the better dung since it contains the larger amount of protein. The percentage of nitrogen in the two lots of dung were as follows :—

	Dung made from Poor Cake.	Dung made from Rich Cake
Quickly available nitrogen	.517	.472
Slowly available nitrogen	.378	.358
Total - - - -	.895	.830

But if the calculations are made to refer to 100 lbs. of nitrogen supplied, then the two lots of dung appear to be identical. In both, for instance, the ratio of quickly available to slowly available nitrogen is the same (10 : 5.7), both suffer substantially the same percentage losses of nitrogen, and oxidise equally rapidly.

The analytical data also enable us to draw up a balance sheet showing the fate of the nitrogen and dry matter supplied to the animal.

Nitrogen Balance Sheet.

SUPPLIED.		RECOVERED.	
In food—Digestible	73.2	*In dung*—Quickly available	47.7
Indigestible	19.6	Slowly available	35.0
In litter	7.2	*In flesh*	5.0
		Lost	12.3
Total	100	Total	100

Dry Matter Balance Sheet.

SUPPLIED.		RECOVERED.	
In food	71.8	*In dung*	42.1
In litter	28.2	*In flesh*	6.2
		Lost	51.7
Total	100	Total	100

Another problem that presented itself was the question of litter. Straw and peat moss were in the first instance compared; it was found that the actual fertilising material directly added to the dung by the litter is of approximately the same value in each case; peat moss contains more nitrogen, but much less potash. One hundred parts contained :—

	Peat Moss.	Straw.
Nitrogen	.83	.49
Phosphoric acid	.10	.32
Potash	.17	1.64*

* Higher than usual. Straw generally contains ·6 to 1 per cent. of potash.

The chief function of the litter, however, is to absorb the urine and especially the nitrogen compounds contained therein, and in this respect peat moss is much superior to straw, possessing three times the power of absorbing ammonia from dilute solutions, and five times the power of retaining it afterwards. Similarly the potash compounds of the urine are better held by the peat moss than by the straw, consequently peat moss dung may be richer both in nitrogen and in potash than straw dung. On the other hand, peat moss decomposes less quickly in the soil than straw, so that the resulting dung may prove less useful in a dry season, especially on light soils.

The suitability of bracken as litter formed the subject of inquiry from Haslemere, where large quantities are obtainable. There is a general belief among those who cultivate the light sand that straw made dung is better than fern-dung, whilst on the clay further off, the preference is rather the other way, and fern dung is considered superior to straw dung.

Analysis showed that bracken cut in September or October was not unlike peat moss in composition, but was somewhat richer; it contained more nitrogen but less potash and phosphoric acid than straw. 100 parts contained :—

	Bracken.	Wheat Straw.
Dry Matter	84.36	86.4
Mineral matter	5.87	5.3
Nitrogen	1.30	.48
Phosphoric Acid	.19	.22
Potash	.16	.63

On the whole the manurial value of bracken is greater than that of straw.

The power of absorbing urine varied with different samples, and was found to depend on the relative proportions of stem and of leaf present. The woody stem was about as efficient as straw, the leaf much more so, especially when crushed. The power of absorbing and retaining ammonia varied in the same way, so that bracken would appear to be a better absorbent than straw. It is however, doubtful whether this advantage would show in ordinary farm practice. In the first place, our experiments were made on equal *weights* of the two materials ; the practical man works with equal *bulks*, and as bracken is less compact than straw he would generally deal with less weight. Secondly, bracken is not as readily trodden down as straw, and has not the opportunity of showing its absorbing power to the full. Examination of two samples of dung, one made with straw and the other with bracken litter showed that the latter was no richer than the former in spite of the potentially higher absorbing power of the bracken.

Equal weights of straw and of bracken dung were dug into plots of light sandy soil and left for five months. It was then found that the straw dung had rotted pretty thoroughly, forming the black homogeneous mass known as humus, while the woody stems of the bracken were still undecomposed. The physical effect on the soil is quite evident. The humus arising from the dung tends to cement the loose soil and to increase the water-holding capacity ; coarse, stemmy material on the other hand tends to open up the soil and facilitate loss of water. On a sandy soil straw dung is preferable because it helps to conserve the water supply ; on a clay soil bracken dung is useful because it promotes aeration and drainage.

CONCLUSIONS.

1. Dung made in a box under bullocks receiving linseed cake and a sufficient amount of litter was found to have lost 15 per cent. of its nitrogen during the process of making. Every precaution possible in practice was taken to guard against loss. This result agrees so closely with that obtained by other English and German investigators that it must be regarded as an inevitable part of the process.

2. The loss is more serious than it appears, for it falls entirely on the quickly available nitrogen compounds ; there is also a further loss since some of these compounds are taken up by micro-organisms and converted into slowly available and less useful substances.

We cannot suggest any way whereby these losses can be obviated.

3. In making dung peat moss is much better than straw as litter, because of its greater power of absorbing and retaining the soluble nitrogen and potash compounds of the urine. But it decomposes less rapidly in the soil, and on light soils peat moss dung may be less useful than straw dung, especially in dry seasons.

4. Bracken is quite a useful material for litter, being nearly as good as straw, but the resulting dung is more useful on heavy than on light soils, because it decomposes less rapidly than straw-made dung.

PUBLICATIONS.

1. The Relationship Between the Amount of Oil in Cake and the Farmyard Manure Produced. G. J. Goodwin and E. J. R. *Journal of the South Eastern Agricultural College*, 1905, No. 14, 187.
2. On the Use of Bracken as Litter. E. J. R. *Journal of the Board of Agriculture*, 1908.

The Amount of Air Space Required in Poultry Houses.

The ventilation of poultry houses is a matter of vital importance to poultry keepers, since overcrowding is known to impair the vitality of the birds, to render them susceptible to numerous diseases, including tuberculosis, diphtheritic roup, etc., and to diminish the number of eggs produced in winter.

At least two views appear to be held by the makers of poultry houses as to the amount of air space required by birds, or, what is the same thing, the number of birds a house will hold. One idea is that each bird must have a certain amount of floor space or of perch room ; if this requirement is fulfilled, the height of the house is not supposed to be of importance. Houses built on this principle aim at securing a maximum floor space ; they are low, and consequently the least expensive on the market. The other view is that each bird must have a certain cubical space, but there is no agreement as to the amount required, and some practical men recommend six, others eight or ten feet. These houses are usually high—six or seven feet—and more or less cubical in shape, so as to obtain the maximum number of cubic feet for a given quantity of timber. In order to decide between these views, measurements were made of the amount of air required by poultry and the amount of impurity produced in poultry houses.

On the College farm there was a house known by long experience to hold thirty-eight birds and keep them in excellent condition throughout the winter. Analysis of the air of this house showed that, on an average, 6.7 parts of carbonic acid was present in 10,000 volumes, the samples being taken between 10.30 p.m. and midnight in winter. A second house, in which birds were also known to do well, contained on an average eight parts of carbonic acid in 10,000 of air. We may, therefore, assume that birds can, without appreciable injury, tolerate an atmosphere containing seven or eight parts of carbonic acid in 10,000, and we suggest that there should not be more than nine volumes.

The conditions necessary to obtain this degree of purity were next investigated.

The old experiments of Regnault and Reiset showed that a bird breathes out about 760 c.c. of carbonic acid per hour, and Richet's more recent results are very similar ; a simple calculation shows that on this basis each bird must have forty-five cubic feet of air per hour in order that the proper degree of purity, *i.e.*, not more than nine volumes of carbonic acid per 10,000, may be maintained. This result was confirmed by enclosing a bird in an air-tight cage, supplying known volumes of air per hour, and estimating the carbonic acid formed. The results were then plotted on a curve, and it was found that the air remained satisfactorily pure, and the nine volume limit was not reached, when forty cubic feet of air per hour was supplied. This, then, is recommended as a suitable air allowance for poultry.

It is not, however, sufficient to give the birds forty cubic feet of air each hour ; the air must be supplied at a suitable rate. If the house is too small, this quantity would create such a draught that the birds could not possibly do well, while, on the other hand, excessive air space is not economical. Experiments were, therefore, designed to ascertain the conditions which give a sufficiently pure atmosphere without involving too great an expenditure in house room.

Two low houses were put up: one (No. 1) provided with a floor; the other (No. 2) had none. No 1 held six birds, No. 2 held eleven. The effect of the floor was, of course, to retard the entrance of air, so that the air changed less frequently than in No. 2. The numbers of birds in the two houses was so arranged, after some preliminary experiments, that there should be in both cases the same amount of carbonic acid—somewhat less than nine volumes; analyses made during the experiment showed that this degree of purity was maintained throughout. Each bird was, therefore, getting about forty feet of air per hour, so that 240 cubic feet passed through No. 1 and 440 through No. 2 in every hour; from the dimensions of the house, it follows that the air in No. 1 changed about five times, and in No. 2 about nine times per hour. Not only was the atmosphere equally pure, but the temperature was also practically equal in the two houses; the birds also had been very carefully balanced, and the only varying factor was the frequency of change of the air.

The number of eggs laid was taken as the measure of the well being of the birds; besides being a sensitive index, it is what chiefly concerns the practical man during winter. It was found that the five hens in house No. 1 laid 194 eggs, an average of 38.8 each, while the ten hens in No. 2 laid 285, an average only of 28.5. Reckoning the eggs at ten for 1s., the difference comes to one shilling per hen for the fifteen weeks (December to March) that the experiment lasted. It is evident that when the air changes five times per hour the birds do better than when it changes nine times, and the reason is not far to seek. Warmth is a very potent factor in determining egg-production, and the birds in the crowded house lose more heat than those in house No. 1, notwithstanding the fact that the temperature is the same in both. Air passing through the house becomes heated about 3° F. by contact with the warm body of the bird: it rises and escapes only to be replaced by cold air. Each particle of air as it passes robs the bird of some of its heat, and, since nearly twice as much air passes through one house as through the other, there is a considerable difference in the heat lost by the birds, which shows itself in the different egg-production. The equality of temperature of the two houses is also readily explained. The thermometer in No. 2 received by radiation from eleven birds almost twice as much heat as the one in No. 1 from six birds. The extra current of air robs it of almost twice as much, so that on the whole there is no difference in the two temperatures.

It was considered by the College poultry experts that house No. 1 was very satisfactory from the financial point of view, the extra income from the eggs more than paying for the extra house room required.

Investigation on similar lines of another house known to be satisfactory showed that the air was changing four times per hour. We, therefore, recommend that the design of the house should be such that the air changes between four and five times per hour, and this requirement was found to be satisfied when the house has a floor allowing air to enter from below, sufficient ventilation in the eaves, and when each bird is allowed ten cubic feet of space.

CONCLUSIONS.

1. The atmosphere of a poultry house should not contain more than nine volumes of carbonic acid in 10,000 volumes.

2. In order that this degree of purity may be attained, each bird must be allowed forty cubic feet of air per hour.

3. This forty feet must be supplied at a reasonably slow rate. Under conditions known by experience to be favourable to the birds, the air changes in a large house four times, and in a small house five times, per hour. This appears to be a very suitable rate of change.

It is clearly impossible for the practical man to test the air in his poultry houses and ascertain the amount of carbonic acid present, nor is there any necessity to do this, because, under similar circumstances, the amount does not show a very great variation. The above conditions are all fulfilled, in houses of a more or less cubical shape and also in the low types of house, when (*a*) there is a floor allowing a certain amount of air to enter from below, *e.g.*, bricks about a quarter-of-an-inch apart covered with peat moss, or spaced boards if the floor is of wood ; (*b*) there is top ventilation, two inches being open under the eaves of a high house, or a few large holes bored in the sides of a low house ; (*c*) each bird is allowed ten cubic feet of space.

PUBLICATIONS.

1. The amount of air space required in poultry houses. K. J. J. Mackenzie and E. J. R. *Journal of the South Eastern Agricultural College,* 1904, No. 13, 84.

2. The relative efficiency of poultry houses with and without ground ventilation. T. R. Robinson and E. J. R. *Ibid,* 1905, No. 14, 175.

3. Ventilation in poultry houses. K. J. J. Mackenzie and E. J. R. *Transactions of the Highland and Agricultural Society of Scotland.* 1908, (v). Vol. 20, 87.

GENERAL NOTES.

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GENERAL NOTES.

PRIZE DISTRIBUTION DAY.

A large company assembled on July 24th for the distribution of prizes by the Right Hon. Ailwyn E. Fellowes. The Principal, Mr. M. J. R. Dunstan, presided, and was supported by the following Governors :—The Right Hon. Lord Ashcombe, The Right Hon. Sir William Hart Dyke, Lieut.-Colonel C. S. Williams, Mr. H. E. H. Rice, Mr. E. Ellis, Mr. E. B. Jay, Mr. W. Welch, Professor G. D. Liveing, Mr. F. S. W. Cornwallis, Mr. W. Ashcroft, Mr. J. Sayer, Mr. A. W. Chapman, Mr. A. Amos, and Mr. E. Vinson. Amongst other visitors were Mr. Laurence Hardy, M.P., and Mrs. Hardy, Mr. J. Rowlands, M.P., Captain Down, R.N., Colonel and Mrs. Campbell, Major-General West, Captain Reid, The Rev. J. A. Halloran, Dr. and Mrs. Sills, Mr. and Mrs. Finn (Deal), Mr. and Mrs. F. Neame, Mr. J. T. Welldon, and Mr. F. W. Crook.

The Principal opened the gathering, and in his speech thought they might congratulate themselves on the fact that a Liberal Government was in power, because by that means they were enabled to have Mr. Fellowes with them. Two years ago the exigencies of the Cabinet meetings prevented his coming, but although they were disappointed then, they were doubly pleased at his being present that day in a public capacity, to see what they had done in the counties of Kent and Surrey to further the cause of agricultural education. He knew all would join with him in giving Mr. Fellowes a hearty welcome to Wye College (applause). It was interesting to hear, in these days, when there was a general exodus of people to the towns (due partly to our system of rural education, and partly to the attractions of better wages and more excitement), the opinion of townsmen upon the industry of agriculture. Agriculture, as he had often pointed out, was a threefold subject—an art, a science, and a business. It was art and science they used in production, while the business side of it was in getting rid of their commodities and in suiting them to their customers' tastes, providing the consumer with what he wanted, and not what they wanted him to want. They could not teach that business judgment at college, that only came from long experience. The science taught was not in a narrow sense, but in its broadest application the teaching of observation in every detail of the industry. He wished particularly that day to appeal to them on behalf of one branch of their work—namely, their research work. In this utilitarian age we were too apt to forget the importance of the accumulation of knowledge for knowledge's sake, and it was for that he pleaded that day. Those who desired immediate results he asked to be patient. Let them go on accumulating the threads, and then some master would come along and weave those threads into a fabric which would be of immense utility to agriculture. They had the men there for such research work—but they had not the means, and what he should like would be someone to provide them with the means of carrying on the work of storing up knowledge, not for to-day—but for the benefit of generations to come. The subject was one of international importance, in his opinion, and should be regarded as such. His predecessor, Mr. Hall, was carrying on that work at Rothamsted, and it would be the greatest benefit to all concerned if they could have a research station established at Wye, as investigation and education should ever go hand in hand. Turning to the conditions of the College during the past year, the speaker said they had reason to be satisfied with the progress which was being made in every department. All round, there was increased activity, and as evidence of the increased utility which the College was to the different branches of the agricultural industry, the number of problems upon which their advice was sought went up by leaps and bounds. As regarded the students, their numbers still increased. In the past session they had 111, an increase of eleven on last year. Further extension in that direction was not possible, for the accommodation in the buildings and in the town had reached bursting point, and therefore it was to be expected that their numbers would remain at about that level. As to the class of men they had as students he had never had a more peaceful or better year in his twenty years of teaching than the last year in that College (applause). He supposed he would get the credit for that—but wrongly so, for it was to his colleagues that the main credit of so successful a result was due (applause). On the last occasion he had complained of some little flaws in our public school system, and he was sorry to say he saw very little improvement to-day. He should be the last to wish to see our public schools turn out young men on the German system. What they wanted at the College was men who would learn to learn in the intervals of instruction. Agriculture was a most complicated industry, requiring knowedge of detail, sound observation, and the best practice, and without these things no man could hope to be successful. It was not only the matter, but the manner, in which our affairs were conducted which mattered, and their desire was to level up the standard of farming in the country, disseminating the best methods of practice of the best farmers in the country. One of the reasons why farmers did not send their sons to an Agricultural College was the natural idea that a parent could teach his son his business at home. In some matters there was certainly no better teacher of the son than the father, but it was in those matters where the father had to seek outside aid that the knowledge gained at the College by the son was of service. All the students living here, and in different parts of the world, he asked to go forward and work in accordance with the motto of the College *Luce et Labore.* Concluding, Mr. Dunstan alluded to the departure from their midst of Dr. Russell and Mr. Mackenzie, two of the most valued members of their staff (applause). Dr. Russell had been with them for six years, and had done brilliant and sound work, and he thanked him for so loyally and courteously working with him during that time. He was going (the speaker mentioned) to join Mr Hall. Mr. Mackenzie had been with them nine years, first as a student, and during the last four years as lecturer in the agricultural department. His enthusiastic and thorough teaching had been of great service, and he could safely say that there were few better teachers of practical agriculture to-day than Mr. Mackenzie (applause). He was going to Cambridge, and both he and Dr. Russell had the best wishes of the Governors, the staff, and the students, in their new work.

The distribution of the prizes and diplomas to the successful students by the Right Hon. Ailwyn E. Fellowes followed, and after this Mr. Fellows made an interesting speech, in the course of which he said that although he had only been there a short time, he had taken the opportunity of going round the buildings to see what was being done, and he could say, without fear of contradiction, that the College was doing a very good and most useful work for agriculture in this country. He hoped before he left to be allowed to go round the farm, which he looked upon as one of the necessary adjuncts to a College like that, and which he was glad to know had been largely increased during the last few months. He had always heard, long before he was connected with the Board of Agriculture, that there was only one opinion about Wye College. He had always heard that it was carried on in the most systematic way, and that the success it had experienced was not only due to the very liberal support it received from the County Councils of Kent and Surrey, but also to the most excellent work which was begun by Mr. Hall, and which was being carried on in a most excellent way by their present principal and staff. The County Councils of Kent and Surrey were to be heartily congratulated on the interest they had taken in the College, sparing no expense in its maintenance and equipment, while the way in which the institution had gone in for the cultivation of hops and fruit deserved enormous credit, and the thanks of agriculturists all over the country, let alone those who resided in the district. He knew from having been at a great many agricultural colleges with which the Board of Agriculture was connected, that farmers were apt to give them rather "the cold shoulder." From last year's report he judged that such was not the case at Wye, seeing that the number of inquiries received from farmers upon various subjects had so increased. It appeared that the farmers were realising more and more that a College in a centre like that must be a benefit to them, and he hoped that as time went on more and more farmers would make use of it. He understood that they had conferences there which he looked upon as an excellent thing, enabling those who attended them to learn something of benefit to them and their business. The College was doing good work, too, in connection with forestry, and he congratulated them on winning the silver medal for forestry at the Royal Show at Lincoln. He hoped that subject would be taken up even more, considering that we were a long way behind almost every other European country in this respect. This College seemed in one respect to suffer in common with all the other agricultural colleges in the country—namely in its lack of funds. Applications for increased grants were received from all alike, and he wished to remind the Governors that there was a committee now sitting upon the question of Agricultural Education, and it was the wish of the Board of Agriculture that they should take steps to lay their views on the subject before the Committee, so that they might have everything before them, previous to issuing their report to Parliament. Money was an important item in all concerns like that and speaking from a purely private point of view, he had long felt that the absolute necessity of assisting such institutions was not realised as it should be. He firmly believed that if the Treasury could help agricultural colleges by giving them increased grants, they would be doing much more for the country as a whole than in many of the schemes which were now before Parliament and the public. He had always felt that in this great agricultural country of ours, they were not being helped to the same extent that similar institutions in other European countries were by their Governments; and he hoped the time was not very far distant when the country would see that to have a prosperous and contented peasantry, they must do everything they could for the maintenance of that great industry upon which they depended so much. Whatever their political views they would agree that no Government could spend money to better advantage than in fostering in every way possible the cause of agriculture, and assisting these colleges, which after so many years of hard work were beginning to hold up their heads and to do an enormous amount of good work for the industry here, and for those who went forth to make what they could in our colonies.

The Right. Hon. Lord Ashcombe (Chairman of the Governors), moved a vote of thanks to the previous speaker for his presence there, and in the course of his remarks said he considered agriculture a science which required to be studied more than any other.

Sir William Hart Dyke seconded, expressing the hope that when there was another Unionist Government in power, their time would come, and that the Treasury would then do tardy justice to Wye College. He alluded to his own thirty years' farming experience, and spoke highly in favour of the Colleges like Wye, which gave the men an opportunity of learning something about the business they were about to undertake. He thanked those present for the support which they gave the institution by being present, and their Principal for the earnest work he was doing in the great cause of agriculture.

Mr. Laurence Hardy, M.P., supported the motion, first alluding to Mr. Fellowes' success at the Royal Show, and later to the successful way in which Mr. E. S. Salmon, one of the College staff, had succeeded in getting Parliament to pass a measure dealing with a pest in fruit culture, and enabling county authorities and the Board of Agriculture to deal promptly with such things in future. He also expressed pleasure at the College's success in forestry, and hoped they would continue their work in this direction, and soon be in a position to give them some information for the better treatment of their woods in Kent.

The motion was carried unanimously, and the Hon. Ailwyn Fellowes briefly replied.

The list of prize and diploma winners was as follows :—

PRIZES :—

Second year—Agriculture, V. S. Rawson and L. E. Knollys, equal. Agricultural Botany, L. E. Knollys. Agricultural Chemistry; V. S. Rawson ; *prox. acc.* W. Hopkins. Book-keeping, Drawing, etc., R. S. Biscoe ; *prox. acc.* R. H. Carter. Veterinary Hygiene, R. H. Carter ; *hon. men.* W. N. Harvey, G. B. Pinyon. Agricultural Entomology, R. H. Carter ; *prox. acc.* G. B. Pinyon.

First year—General Science, H. F. Carter ; *prox.* D. V. Bacon. Agriculture, B. T. Dane ; *hon. men.* D. V. Bacon, E. J. Carlisle, H. F. Carter, A. G. Cutler.

CERTIFICATE :—

Second year—Agriculture, G. Harbord ; *prox.* F. K. Willis.

MEDALS :—

Design for Farm Buildings—O. E. Greening.

Collection of Botanical and Entomological Specimens—T. Chuidian ; *prox. acc.* W. Hopkins.

Poultry—A. V. D. Rentoul.

DIPLOMAS AND CERFIFICATES :—

Diplomas with Honours. Agriculture—R. N. Dowling. Entomology—R. N. Dowling and F. P. Jepson. Veterinary Science—G. Fenoulhet.

Diplomas—T. Chuidian, L. E. Knollys and V. S. Rawson.

Certificates—K. H. Beazley, F. Blest, R. G. Chandler, J. R. Cheesman, M. W. Colomb, J. A. Drew, G. Harbord, F. H. Vaughan and F. K. Willis.

The following students satisfied the examiners :—

Part I. of the Diploma :—D. V. Bacon, H. F. Carter, B. T. Dane, R. F. Hankins, L. Hopkins, E. B. Keiller, C. W. Jemmett, J. M. Manapat.

Part II. of the Diploma :—R. S. Biscoe, R. H. Carter, W. R. Dunlop, L. R. de Eizaguirre, G. A. Goodman, W. N. Harvey, W. Hopkins, G. B. Pinyon, A. M. Ridley, H. Tonks.

Part I. of the Certificate :—S. M. Bertie, P. Blagrove, E. H. Davies, G. H. Garle, F. B. Ryder, C. P. Salvago, W. S. G. E. Tremayne, W. R. Tucker, C. L. Walters.

SUMMER COURSE FOR TEACHERS.

The Summer Course for Teachers was held from August 19th to 31st.

The course was divided into Elementary and Advanced, the greater proportion of the time being spent in the Chemical and Botanical Departments. Zoology also formed an important subject, and in addition instruction was given in Farm Foods, Land Measurement, Horticulture, Beekeeping and Poultry. A Nature Study excursion was made to various places of interest in Romney Marsh, the teachers being accompanied by the following members of the staff: Mr. F. V. Theobald, Dr. E. J. Russell, Messrs. S. T. Parkinson, E. S. Salmon, B. N. Wale and T. R. Robinson. Mr. C. Stokes, who has a special knowledge of the Marsh district, was also one of the party.

Popular lectures were given by Mr. E. S. Salmon on "Fungoid Diseases," by Mr. H. F. Abell on "My Experience of an Earthquake," and by Dr. E. J. Russell on "The Work of the Rothamsted Experimental Station."

The total number of teachers who attended the course was sixty-eight, thirty-eight coming from Kent, twenty-nine from Surrey, and one attended privately.

HOP GROWERS' CONFERENCE.

A meeting of hop growers was held at the College on November 27th, which was largely attended, and at which interesting papers on the "Influence of Fertilisation on the Growing Out of Hops," by Messrs. E. S. Salmon and Arthur Amos, on "Arsenic in Hops" by Mr. M. J. R. Dunstan (the Principal) and Dr. W. Goodwin, and on "Eelworms" by Mr. F. V. Theobald, were read. Mr. E. C. Lister-Kay occupied the chair, and acceptances were received from a large number of farmers and others in the district, including: Messrs. A. Amos, Wye; F. S. W. Cornwallis, Maidstone; G. M. Arnold, Gravesend; A. D. Hall, Harpenden; W. Chambers, Southfleet (governors); Lieut.-Colonel Honeyball, Sittingbourne; Messrs. W. H. Chantler, Eastwell; T. Weston, Cranbrook; E. Reader, Brenchley; A. Miskin, Maidstone; H. Amos, Faversham; W. T. Hinds, Smarden; H. L. Mills, Smarden; R. H. Green, Willesborough; E. Le May, London; W. R. Harvey, Chartham; H. W. Clements, Boughton Aluph; F. Neame, Faversham; H. T. Manwaring, Marden; T. A. Wimshurst, Brenchley; S. Thirkell, Benenden; A. Fleming, Chart; H. Dungey, Frittenden; O. Dungey, Staplehurst; H. B. Amos, Ashford; R. W. Mitchell, Yalding; C. Mantelow, Staplehurst; A. J. Burrows, Ashford; T. H. Oyler, Maidstone; F. G. Chambers, Sutton Valence; W. Maylam, Pluckley; J. D. Large, Goudhurst; E. J. Overy, Paddock Wood; W. W. Berry, Faversham; C. E. Cutbill, Smarden; G. F.

Whiteman, Canterbury ; A. Mannington, Yalding ; E. A. White, Paddock Wood ; C. S. Hardy, Chilham ; W. Rogers, Farningham ; W. T. Palmer, Willesborough ; J. Dungey, Cranbrook ; C. F. File, Wye ; Edwin Finn, Lydd ; G. Kelson, Tenterden ; A. Brown, Hothfield ; W. H. Hubble, Hunton ; J. Butler, Smarden ; H. H. Spanton, Chislet ; J. C. Barnett, Staplehurst ; W. V. Tabrett, Boughton Aluph ; E. W. Dungey, Cranbrook ; E. Manningford, Benenden ; and J. D. Maxted, Littlebourne.

The morning's proceedings included the papers on "The Influences of Fertilisation on the Growing Out of Hops" and "The Raising of New Varieties of Hops" by Messrs. E. S. Salmon and Arthur Amos, a full report of which will be found on pages 364 and 392.

Luncheon was then served, after which, following the toast of the King, Mr. Lister Kay submitted Success to the Institution, and, dealing with the work at the College, said year by year the value of such institutions in promoting the success of agriculture, and in training their youths to remain in the state of life to which they were born, instead of sending them to seek their fortunes in foreign countries, was becoming recognised. They at the College were men of science, and the union of such men with the workers in the practical side was fertile, not only to the contracting parties, but to the whole of the rest of the world. He coupled with the toast the names of Mr. Cornwallis and Mr. Dunstan.

Mr. Cornwallis, in reply, said he had seen great progress at the College, which was founded on sure principles by Mr. Hall, and carried on by their present head, and to-day they were in the position of being short of accommodation, and were obliged to turn away students who wished to come for the very excellent education the College gave. In the students they had a set of young men who would do the College credit, and in the staff they had men who could not be excelled, and he did not believe they could be equalled. Politics had been barred at this gathering, but he had heard of the likelihood of the repeal of the Act which prohibited the introduction of fruit pests into this country, and he appealed strongly to the representative of the Board of Agriculture present, on behalf of the fruit growers, to do what he could to stop its revocation.

Mr. Dunstan, in reply, said such institutions as theirs, where research was carried on, ought to be recognised and aided by the State, for the work itself could not be pecuniarily beneficial to researchers. He was glad to see so many hop growers present, and he thought they ought to form themselves into a hop growers' association, for the protection of their own interests (hear, hear). If the growers would take the commercial side, they at the College would be pleased to join them to give their assistance on the scientific side of hop culture.

The afternoon's proceedings opened with the delivery of a lecture on "Arsenic in Hops," by the Principal, which had been prepared by himself and Dr. Goodwin. Mr. Dunstan stated that hops when brought to the oast were practically free from arsenic, and if in the drying pure sulphur and pure anthracite were used, the traces of arsenic in the hop would be a negligible quantity, and would have no deleterious effect on the beer brewed from them. He pointed out that traces of arsenic could be found in almost every form of food and in some cases the percentage was higher than in the case of beer, but he wished it to be understood that he did not suggest that it was in such quantities as to be detrimental. The medicinal dose of arsenic was one hundreth part of a grain, and that could be safely taken. At the present time there was no legal standard fixed limiting the quantity of arsenic in hops, and if one were set up it might cause a great hardship, especially on the smaller growers, for it might mean the adoption of the method of drying by hot air, at present employed on the Continent and in the United States. A standard of one-fiftieth part of a grain to the pound, however, was one which could be adopted with perfect safety, and in this event the present system could be continued, provided pure sulphur and pure anthracite were used in the drying process. He did not say that it was necessary to have a standard at all, but this was a suggestion in view of the recent trouble which had arisen in connection with the matter. He read a letter from Mr. Lawrence Briant, the well-known analyst for brewers and hop merchants, on the subject, in which Mr. Briant stated that a standard of one-fiftieth part of a grain to the pound could be adopted with safety, and added that he advised his brewers that they could use hops which kept below that standard with perfect safety. In a discussion which followed, Col. Honeyball said he did not think growers need seriously trouble themselves on the matter, which was a trade question, and one raised by merchants and brewers who, in face of the falling market, wanted to get the hops off it. Now that the Hop Growers' Protection Association had been formed, he did not think they would hear much about contamination from arsenic.

Mr. F. V. Theobald then delivered a lecture on "Eelworms," a troublesome pest which attacks the roots of the hop plant and also other things, such as oats, wurtzel, buckwheat and rape. The pest was, he said, most harmful in soil deficient in lime, but while they did not thrive where lime was present in the soil, this did not kill the insects. The best remedy was the treatment of the soil with two or three cwt. of sulphate of potash per acre.

After the reading of Messrs. Salmon and Amos' paper "On the Value of the Male Hop,"* a lengthy discussion took place. Among the speakers were the following:—

Mr. W. H. Hammond (Canterbury) stated that the scientific investigations reported by Messrs Salmon and Amos, bore out his father's practice at Petham in 1820, where male hops were always grown, and Petham hops always made top prices and maintained their good properties. Five male hills per acre were planted, and it was found that the constitution and condition of the hops were improved by the influence of the males, and they were better able to withstand an attack of mould. German practice was not for the English grower to follow as the Germans used no English hops.

Col. Honeyball (Teynham) asked if the soil were of the same composition at the part of the garden which was fertilised as in that of the non-fertilised part, and Mr. Amos replied that there was no difference in soil or subsoil.

Mr. Lord (Northiam) asked for a further explanation of the figures, which were explained by Mr. Amos.

Mr. Mannington (Yalding) had for thirty-five years planted male hops. He stated that healthy hops were procured in greater quantity by having male hops in the plantation. He had noticed also the character of Bavarian hops in having longer cones, and the petals were more closed up.

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* This paper is given in full at page 364.

Mr. Salmon stated that probably the difference in the soil and climate of Germany had more to do with the size and appearance of the German seedless hop than the mere difference of variety.

Mr. Langridge (Eastbourne) suggested that German varieties should be introduced into the College garden, and experiments made with them for ten years. Mr. Amos stated that the German varieties which had been grown for some years in the College garden showed a decrease in the number of the bracteoles.

Mr. Cook (Detling) said that Fuggles do well without fertilisation and that Goldings evidently require it—could other varieties be classed under the same headings? Mr. Amos stated that at present it was not possible to so classify any other varieties.

Mr. Santer asked the name and character of the male hop, which caused the improvement. Mr. Amos replied that the pollen dust of any kind of male hop is able to fertilise the "burr," and so cause the production of seed in the hop.

Mr. Hammond stated that the number of bracteoles in the Early Bird was greater than in other English hops, and that according to Prof. Percival the Early Bird was the nearest approach to the German hop.

Mr. Amos stated that the Early Bird comes into "burr" early, and that the "burr" is often not fertilised, because there are no males in flower at that time. The "burr" not being fertilised, hangs about a long time. Under such circumstances, the hop being seedless more resembles the German hop.

In the discussion following the reading of Messrs. Salmon and Amos' paper "On the Raising of New Varieties of Hops,"* the Chairman stated that poultry breeding, to which he had given considerable attention, resembled the breeding of hops, and that it was most important to know the parentage of the male as the influence of the qualities of the male was of most serious import. He asked if the character of the mongrel was so fixed that the cuttings would be true to name. Mr. Amos explained that, after a new variety had been obtained by crossing, propagation from this variety by seed would certainly give rise to individuals of widely different characters, but that in the case of hops, where the propagation would be by means of cuttings, these would be fixed in type and true to name.

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* This paper is given in full at page 392.

Mr. Mount (Canterbury) gave his experience of the perpetuation of a bad strain by cuttings.

Mr. Mannington stated that in twenty hills of seedlings all were different.

Other speakers referred to the Henham and Jones hops, and to the Bluneth seedlings.

At the conclusion, Colonel Honeyball proposed a vote of thanks to the Chairman, which was carried with applause. Mr. Dunstan, speaking in support, said that at the next conference in 1909, the subjects for discussion would probably be "Mould" and "Hop-Drying," and he invited information from hop growers on both subjects.

POTATO SHOW AND CONFERENCE.

The annual show and conference in connection with the National Potato Society were held on Wednesday, October 2nd, 1907, at the College, and with it the annual competition in connection with the courses of instruction upon cottage gardening, poultry rearing, and bee-keeping, given through the county by lecturers under the Kent Education Committee. There was a big attendance, and two very fine shows were to be seen. With regard to the potato show, in which there were entries from England, Ireland, Scotland, and Wales, the exhibits were not quite so numerous as at the last show, probably on account of the disease from which the tubers have this year suffered, and also, no doubt, because of its being somewhat early for the Scotch exhibitors. What little the show lacked numerically, however, was amply made up by the excellence of the exhibits, for a finer lot of tubers than those staged would indeed be difficult to find.

During the afternoon, a very interesting conference in connection with the Potato Society was held, over which Mr. M. J. R. Dunstan (the College Principal) presided. Mr. W. P. Wright, of Lyminge (the Chairman of the Society) briefly introduced

Mr. Dunstan to the assembly, after which Mr. Dunstan gave a practical address, in the course of which he detailed the results achieved from some trials in potato growing which had been carried out on the College Farm during the year. The chief characteristic should be freedom from disease, but he did not think they had a single real disease resisting potato on the market at the present time. Its yielding qualities, keeping character, cooking value, size, shape, depth of eyes, etc., were also characteristics to be considered, and he thought at present they must endeavour to educate the public into what a good potato was, and then educate the public's cooks into how to cook a good potato. One of their experiments carried out with Factors on half-acre plots, was to see how far sprouting the seed tended to increase the crop or otherwise. The result of this had been that the half-acre of sprouted seed had grown tubers at the rate of 14 tons per acre, while the unsprouted seed had only produced 12½ tons to the acre. Therefore sprouting gave a sufficient increase in the yield to make it a commercial success. Their "international" trial between Scotch, Irish and English seed on small plots resulted in the English seed giving 11 tons per acre, the Irish seed 12 tons and the Scotch seed a little over 13 tons per acre. This was on the farm, but on the garden plots the Irish seed had beaten the Scotch seed by a little. He hoped from that a little more prosperity would come to Ireland from the growth of the potato, but undoubtedly the best seed for most purposes when a change was wanted was seed from Scotland, although a change was also desirable from North to South and from East to West.

Mr. Salmon followed with an interesting lecture, illustrated by many lantern slides, on "Some Fungus Diseases of the Potato." Three diseases were described, *viz.* the well-known "potato disease" or "blight," (*Phytophthora infestans*), the potato "scab" (*Oospora scabies*); and the "Warty Disease" or "Black Scab" (*Chrysophlyctis endobiotica*).

With regard to the common potato "blight," the lecturer pointed out that it was caused by a definite fungus or "mould" which first appears on the leaves about the middle or end of July, and soon causes them to turn brown or black in places, and finally the whole of the haulm may be destroyed. In damp, close weather the fungus spreads, by means of its spores, with great rapidity through the whole field. Further growth of the plant is thus stopped, and only a very poor crop of potatoes may be obtained. Further, in many cases the tubers themselves become infested with the spawn of the fungus, and many of these rot either in the ground before being lifted, or in the " clamp " or " pie " when stored. The disease is frequently introduced the following season by means of such diseased " seed." This potato " blight " can be entirely prevented by the application, before the disease has appeared, of properly made Bordeaux mixture (copper sulphate 12-lbs., quicklime 8-lbs., water 100 gallons). Directions as to the best method of making and applying this fungicide are issued in one of the College's Leaflets, and can be obtained on application. If the acreage of potatoes is very small, the necessary spraying can be carried out with the " Eclair " knapsack pump ; if, however, 10 acres or upwards are grown, a horse spraying machine, of which several are on the market, should be used. The cost is 6s. to 7s. per acre for each spraying, and two good applications are usually amply sufficient.

The lecturer remarked that in such a season as the present those growers who have sprayed their potatoes have reaped a handsome profit. At the College the spraying resulted in a gain estimated at from two and a half to three tons per acre. In the series of experiments which have been carried out during the past five years in Ireland by the Irish Board of Agriculture, the *average* increase of crop per acre due to spraying is over two tons. Similar evidence, showing the great value of spraying potatoes, comes from the Experiment Stations in the United States. In an extensive series of " farmers' business experiments " on some 170 acres of potatoes, carried on by the growers themselves for the past four years, in the State of New York, there has been an average net profit of £4 15s. per acre due to spraying.

The second disease treated of was the common " potato scab." This disease is caused by a very minute fungus, the germs of which can lie dormant in the soil for a number of years, until potatoes are grown again, when the crop is attacked. In certain districts the soil has become so infested with the " scab " germs that growers are suffering considerable losses. It has been found that the application of lime very materially increases the scabbiness of the crop. Nothing has yet been discovered which will eradicate the " scab " germs in infested soil, but sulphur, applied at the rate of 300 lbs. to the acre, often decreases the percentage of " scab " to a remarkable extent. The " seed " should be rolled in the powdered sulphur, and the rest of the sulphur should be sprinkled in the open row.

" Scab " is often introduced into a field by the use of " scabby " seed. If such seed (before being cut) is steeped for one hour in corrosive sublimate (1 part to 1,000 parts of water), or, preferably, for two hours in formalin (1 pint of commercial formalin to 36 gallons of water), it will kill all the " scab " germs, and there will be no danger of introducing the disease to a farm through the use of " scabby " seed. Some varieties of potatoes, *e.g.* Charles Fidler, have proved to be resistant to " scab."

The third disease which was described is one that is not yet known to occur in the South of England. This is the " Warty Disease " or " Black Scab," which was introduced into England from the Continent about ten years ago. It is now known in some six counties in the Midlands, in Wales, and also in Scotland. The potatoes which are attacked develop curious warty " gall "-like out-growths, and in severe attacks the entire tuber is transformed into a useless wrinkled mass resembling a piece of coke. When the " seed " potato is attacked at the " eyes," no crop at all results. Very serious losses have already occurred in the Midlands.

The lecturer called attention to the dangerous nature of this new disease, and urged that something should be done at once to stop its spread. He suggested that the Farmers' Clubs in England should send resolutions to the Board of Agriculture, urging them to deal with the disease by vigorous measures while it was confined to a few counties.

Actual examples of the diseases mentioned were shown, and also a series of lantern slides prepared from photographs, illustrating the microscopic and other details of the fungus, causing the respecttive disease.

BRITISH DAIRY FARMERS' ASSOCIATION.

A large party of the members of the British Dairy Farmers' Association, who were holding their annual gathering at Tunbridge Wells, visited the College on June 12th. The Principal (Mr. M. J. R. Dunstan) welcomed the visitors in the Gymnasium, which was set out specially for the purpose, and then proceeded to give a brief historical sketch of the College from the time of its foundation centuries ago to the present day. Captain Bellasis, on behalf of the Association, expressed his thanks to the Principal for his welcome and information, and the party then proceeded to inspect the various departments of the College. Those present included Lord Northbourne, Mr. F. S. W. Cornwallis (Vice-Chairman Kent County Council), Lieut-Col. C. S. Williams, Mr. Wm. Ashcroft, Professor Nuttall (Uttoxeter), Professor A. Blundell (Royal Agricultural College, Cirencester), Captain R. O. Bellasis (Coventry), Mr. A. Amos (Wye), Messrs. J. Brown (Tunbridge Wells), V. B. Chalk (Beckenham), L. M. Douglas (Edinburgh), C. L. Fox (Shipbourne), J. W. Lord (Northiam), S. P. Page (Mottingham), P. Peters (Tunbridge Wells), S. J. Pocock (Charlton), W. Roper (Tunbridge Wells), W. C. Brown (Appleby), and members of the Association from all parts of the country.

After inspecting the College, the party returned to the Gymnasium to hear a paper by Dr. Russell upon "The Effect of Food on Milk," a subject, the doctor remarked, of the greatest importance to the practical man, and of the highest interest to the scientist. They got, perhaps, more inquiries from dairy farmers about the unfortunate morning's milk than about anything else; the afternoon supply was usually satisfactory, but it was often exceedingly difficult to keep the morning milk up to the 3 per cent. standard. The two chief causes appeared to be—(1) most men kept large-frame, deep-milking cows, which did not normally give milk with much more than 3 per cent. of fat; (2) the milking had to be done at hours suiting the milk train and not at hours suiting the cow. It was not too much to say that if the animals could be milked at twelve-hour intervals, say, at 5 a.m. and 5 p.m., most of the trouble would disappear. As to the relation between the yield of milk and the quantity of food, when more food was supplied the animal did better herself, and also gave more milk, but the extra milk did not correspond to the extra food. The vitally important point to the farmer was that up to a certain point an increase in the amount of food supplied gave a profitable increase in milk, but beyond this point the increased milk yield no longer paid for the increased food. Every man must therefore decide for himself just where to draw the line, but there were one or two general principles which furnished valuable guidance. If an animal was to lay on flesh, or to produce milk without losing flesh, it must receive more than a maintenance ration, and the greater the quantity of extra food the more there was available for flesh or milk production—up to a certain point. Unfortunately, it was not possible to give a good average English ration, because no sufficient number of rations had been collected and examined. Still, good English feeders recognised that in order to produce milk, a cow required a diet rich in protein, and highly nitrogenous substances—cotton cake, bean meal, etc., were well recognised dairy foods. The value of a set of standard rations would be that one could tell whether and to what extent a particular ration was abnormal ; it was, for instance, well known that to feed excess of protein was extremely wasteful. There was a limit to the yield of milk beyond which the cow could not go, no matter how much food was supplied to her. The limit depended on the capacity of the udder and the power of the animal to transform into milk the food which had been digested and taken up into the body ; these features were born in the animal, and their full development depended on proper management. They might, and they should, breed for them, but they could not put them into an animal that did not possess them. With regard to the effect of food on the percentage of fat, a study of the most important experiments made, led to the conclusion that if animals were well housed, well looked after, and on a ration which kept them in good condition, then a change to an equally suitable ration would have little or no permanent effect on the fat in the milk. But if the animals were on an unsuitable ration, or received excess of watery food, it was quite conceivable that the fat content could be increased by improving the ration. Further experiments were necessary on this point.

Dr. Russell then referred to the effect of certain diets upon the composition of milk fat, and in conclusion said there were other questions he only touched upon to elicit information, and this information he hoped the Association would be able to furnish for the benefit of the chemist. One important point was the effect of food on the palatability of butter. It was asserted by some that cows pastured on grass gave a more palatable butter than cows fed on roots, hay, cake, etc. ; others said that by properly managing the ripening and churning, the difference in flavour disappeared. Then there was the question of colour. In some trials made at Wye, it was found that carrots gave a rich colour to the butter, but other foods were supposed to have the reverse effect. Lastly, there was the very interesting point raised by Mr. McConnell last year—the influence of the soil on the character of the milk. Authoritative information on these and similar points was very desirable.

Mr. Geo. Taylor (Crawford) proposed a vote of thanks to Dr. Russell for his paper, the contents of which he described as very valuable. He also emphasised the importance of stockmen having impressed upon them the necessity of giving cows the proper rations, no more and no less.

Mr. W. C. Brown, Appleby, Lincolnshire, seconded the vote of thanks, and also spoke in high appreciation of Dr. Russell's paper.

Professor Blundell supported and expressed his agreement with the propositions put forward by Dr. Russell. Speaking of the type of food best suited to dairy cattle, the Professor said general experience was that it should be somewhat of a laxative nature. He also laid great stress upon the good effects of absolute cleanliness in the sheds.

Mr. F. J. Lloyd (London), in giving the proposition his support, mentioned, amongst other things, colour. The colour of the fat in the milk he was convinced had some relation to the green colouring matter of the grass, and just as the green of the Virginian creeper turns yellow in the autumn, so did the green of the grass turn yellow by the process of being made into milk by the cow.

Dr. T. J. L. Van Rijn, Friesland Agricultural Commissioner, London, having spoken upon the effects of the nervous system upon the milk, Lord Northbourne, who had been voted to the chair, stated that the result of his observations was that the natural food of the cow was grass, and that if the cow was fed in the summer mainly on grass and in the winter upon hay, and perhaps a little crushed oats, satisfactory results were obtained.

The motion was then put and carried, amid loud applause, and Dr. Russell acknowledged the compliment.

Luncheon was subsequently served, after which the Principal gave " The King of farmers and the farmers' King." Mr. Theobald (the Vice-Principal) proposed " Success to the British Dairy Farmers' Association," of whose work, both from commercial and educational points of view, he spoke highly.

Lord Northbourne, whose name was coupled with the toast, replied, and, in doing so, regretted the absence of Sir Edward Strachy, of the Board of Agriculture, and of Mr. Jesse Collins.

Captain Bellasis proposed "The Governors of Wye College," and coupled with it the name of Mr. Dunstan.

The Principal, in reply, described the functions of the College, namely, education and investigation—as they taught they investigated, and as they investigated so they passed on the digested results of their education. He spoke of the great success of the College and of its old students, who were winning it credit in all parts of the world, as well as at home. Turning to agriculture generally, the Principal said it was suffering from two causes: low prices and inefficiency and insufficiency of labour. As a remedy for inefficient labour, he advocated the proper education of our rural population. As to the present education, it was not wrong in quantity, but was wrong in quality. We had got to train teachers who would go into the elementary schools of the rural districts and teach that which appertained to country pursuits, and not those things which appertained to towns. As to the insufficiency of labour, Mr. Dunstan in a measure supported the principle of small holdings, but also said the farmer would have to face higher wages. Where the extra money was to come from he did not know, but it certainly could not be paid out of present profits. In regard to low prices, Mr. Dunstan said the College was a place where it could not very well be discussed.

The party subsequently inspected the College Farms and Gardens.

WEATHER REPORT & SUMMARY FOR 1907.

	No. of days rain fell.	Inches of rain.	Average of Daily Sunshine		Notes.
			h.	m.	
January	7	1.13	2	0	Very dry month, more than average sunshine ; first half warmer, second half cooler than usual ; warmest day 48° ; coldest night 16° frost. High wind on three days ; rest of month unusually still.
February	9	1.15	2	5	Cold, dry, average sunshine ; coldest February for five years : down to 19° frost. Wind few days strong from N.W. ; rest of month light.
March	10	0.76	6	2	Days dry, warm and very sunny, up to 63° and 69° ; nights almost all cold, 12° frost on 21st ; notable absence of east winds.
April	14	2.58	4	0	Rainy month ; on 19th and 20th 13° frost : very little damage to fruit. Gooseberries suffered slightly.
May	14	1.86	4	40	Changeable temperatures, nights fairly warm, except one night with 5° frost.
June	13	1.95	4	31	Days rather cold and sunless. Night temperatures above average.
July	10	1.36	4	9	Temperature about the average.
August	11	1.83	4	15	Rather dull and cold.
September	5	0.33	5	50	Bright and dry. On 24th 5° frost on grass.
October	23	5.62	2	12	Very wet month.
November	9	2.42	1	27	Warm month, very little wind.
December	14	2.45	1	18	Very warm month, many days up to 50° and over ; last three days cold.

Temperature.—Average temperatures of the months were rather below average, except March, which was a very warm month, the last four months were above average.

Sunshine.—Up to average, March was sunniest, September next, these were brighter than any of the summer months.

Rainfall.—Total 23.44 inches, which is below average. October with 5.62 inches was the only wet month.

STAFF PUBLICATIONS.

Since the last Journal the following publications by members of the Staff have been issued :—

By F. V. Theobald.

1. Report on Economic Zoology for the year ending April 1st, 1907, pp. 152. 20 figures and 29 plates. (1907). 2s. 6d.
2. Economic Ornithology in Relation to Agriculture, Horticulture and Forestry, pp. 21 *Science Progress*, No. 6 (1907).
3. The Enemies of the Rose, pp. 85 (1907). (National Rose Society). Massee & Theobald. 2s. 6d.
4. Notes on some Transvaal Mosquitoes, including two new species and a new variety. *The Entomologist*, May. pp. 106-109. (1908).
5. Eelworms in Corn Crops. *Agricultural Gazette*, September, 1907.
6. Grubs in the Soil. *Agricultural Gazette*, June, 1907.
7. Parasitic Liver Disease in Poultry. *Official Report of the Second National Poultry Conference*, pp. 181-186. (1908).
8. Some New Mosquitoes from Ceylon. *Journal Bombay Natural History Society*. Vol. XVI., pp. 237-250. (1907).
9. Catalogue of the Culicidæ in the Indian Museum, Calcutta. *Indian Museum Records*. (1908).
10. Articles on Injurious Insects. *The Standard Cyclopedia of Modern Agriculture*. (1908).
11. Turnip Fly. *Daily Telegraph*, July 10th, 1908.
12. Caterpillars on Fruit Trees. *Daily Telegraph*. July 23rd, 1908.
13. The Prevention and Destruction of Caterpilars on Fruit Trees. Leaflet No. 10. S. E. Agricultural College. (1908).
14. Fruit Tree Pests and a Spraying Calendar for Fruit-growers. Spencer U. Pickering and F. V. Theobald. (In the press). 1/6.

By E. S. Salmon.

1. The American Gooseberry Mildew attacking the Red Currant. *Gardeners' Chronicle*. July 13th, 1907.
2. Cherry Leaf Scorch. *Journal of the Board of Agriculture*, September, 1907, p. 334.
3. A New Chrysanthemum Disease. *Gardeners' Chronicle*, September 21st, 1907.

4. Notes on some species of *Erysiphaceae* from India. *Annales mycologici*, Vol. V., p. 476. (1907).
5. The American Gooseberry Mildew; an epidemic fungus disease now invading Europe. *Proceedings of the Association of Economic Biologists*, Vol. I., p. 110. (1907).
6. Apple "Leaf-Spots." *Gardeners' Chronicle*, November 2nd, 1907.
7. The Spread of the American Gooseberry Mildew in England. *The Fruitgrower*, June 27th, 1907).
8. The Spread of the American Gooseberry Mildew in England. *The Fruitgrower*, July 11th, 1907.
9. The American Gooseberry Mildew. *The Times*, July 8th, 1907.
10. The American Gooseberry Mildew. *The Times*, December 23rd, 1907.
11. The American Gooseberry Mildew. *The Times*, January 1908.
12. The American Gooseberry Mildew. *The Standard*, November 26th, 1907.
13. The "Black Scab" of Potatoes. *The Standard*, December 13th, 1907.
14. Notes on the Hop Mildew (*Sphaerotheca humuli* (DC.) Burr). *Journal of Agricultural Science*, Vol. II., p. 327. (1907).
15. The European Gooseberry Mildew attacking the Red Currant. *Gardeners' Chronicle*, October 19th, 1907.
16. "Black Scab" or "Warty Disease" of Potatoes. *Gardeners' Chronicle*, December 7th, 1907.
17. Apple Mildew. *Gardeners' Chronicle*, August 31st, 1907.
18. Three Good Fungicides. *Leaflet of the S.E. Agricultural College.* (Revised).
19. "Black Scab" or "Warty Disease" of Potatoes. *Leaflet of the S.E. Agricultural College.*
20. The Board of Agriculture and the American Gooseberry Mildew. Paper read before the Canterbury Farmers' Club and East Kent Chamber of Agriculture, January 18th, 1908.
21. A new Cherry Disease. *Gardeners' Chronicle*, April 4th, 1908.
22. Fruitgrowing and the Conditions under which it may thrive. *Journal of the Farmers' Club*, April, 1908.
23. Disease of Seakale. *Gardeners' Chronicle*, July 4th, 1908.

24. The *Erysiphaceae* of Japan, III. *Annales mycologici*, Vol. VI., p. 1. (1908).
25. Apple "Scab" or "Black Spot." *Journal of the Board of Agriculture*, June, 1908.
26. Ueber das Vorkommen des amerikanischen Stachelbeer-Mehltaus (*Sphaerotheca mors-uvae* (Schwein.) Berk.) in Japan. *Zeitschr. für Pflanzenkrankheiten*, XVIII. Band, p. 59. (1908).

By E. S. SALMON and ARTHUR AMOS.

On the Value of the Male Hop. *Leaflet of the S.E. Agricultural College*, May, 1908. Reprinted, with discussions, in the *Journal of the Institute of Brewing*, XIV., p. 309. (1908).

By S. ROTHWELL.

A New Mosquito from India. *The Entomologist*, pp. 34-36. February, 1907.

By C. FENOULHET.

The Black Anthonomus (*Anthonomus rubi*) attacking the Strawberry. *Journal of the S. E. A. College*, No. 16, pp. 10-108. (1907).

By T. W. CAVE.

A few Parasites of the Fourth Stomach and Intestines of Sheep and Cattle. *Transactions of National Veterinary Association*, Gt. Yarmouth Meeting. (1907).

BY FRANCIS V. DARBISHIRE AND E. J. RUSSELL.

Oxidation in Soils, and its Relation to Productiveness. *Journal of Agricultural Science*, Vol. II., Part 3., December, 1907.

By CECIL H. HOOPER.

Some Notes on the Foods of Birds. *Journal of the Board of Agriculture*, October, 1907.

By H. W. KERSEY.

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